Office Of The Secretary Of Defense (OSD)
Deputy Director Of Defense Research & Engineering
Deputy Under Secretary Of Defense (Science & Technology)
Small Business Innovation Research (SBIR)

Program Description

Introduction

The Deputy Under Secretary of Defense (Science & Technology) SBIR Program is sponsoring two new technology area initiatives this year, Cognitive Readiness Technology and Smart Sensor Web Technology. We are also co-sponsoring a third technology area, biomedical technology topics, with Defense Health Affairs.

All three Services and Special Operations Command are participating in the OSD program this year. The service laboratories act as our OSD Agent in the management and execution of the contracts with small businesses. The Army, Navy and Air Force laboratories, often referred to as a DoD Component acting on behalf of the OSD, invite small business firms to submit proposals under this Small Business Innovation Research (SBIR) program solicitation.

Firms with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercialize the results are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results.

The DoD Program presented in this solicitation strives to encourage technology transfer with a focus on advanced development projects with a high probability of commercialization success, both in the government and private sector. The guidelines presented in the solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

The topics are presented in three sections, corresponding to the technology areas cognitive readiness, smart sensor web and biomedical. The topic descriptions, that follow this program overview section, are listed below.

The Cognitive Readiness Topics are:

- OSD00-CR01 Automated Dialogue Modeling Using Natural Language Understanding in ADL, by the Naval Air Warfare Center Training Systems Division (NAWCTSD)
- OSD00-CR02 Training Users' Cognitive Readiness for Combat Command Using an Intelligent Tutor to Model Expert Mentor Interactions by the US Army Research Institute (ARI) for the Behavioral and Social Sciences
- OSD00-CR03 A Personal Health and Fitness Assistant by the US Army Medical Research Acquisition Activity (MRMC)
- OSD00-CR04 Digital Resource for Instructional Design in CBT Authoring Environments by the Office of Naval Research (ONR)
- OSD00-CR05 Dismounted C4ISR Data Presentation and Dissemination by the Army Research Laboratory (ARL)
- OSD00-CR06 Enhancing Situation Awareness in Military Operations by the Army Research Institute (ARI), Ft. Benning
- OSD00-CR07 **P**ersonal **E**ducation and **T**raining **A**ssistant for Distance Learning (PETA) by the Naval Air Warfare Center Training Systems Division (NAWCTSD)
- OSD00-CR08 Common Operating Picture for Stability and Support Operations by the Army Research Laboratory (ARL), Ft. Huachuca
- OSD00-CR09 Cognitive Learning Strategies for Medical Skills Training and Sustainment via Distance Learning Means by the Special Operations Command (USSOCOM)
- OSD00-CR10 Computerized Cognitive Assessment Battery by the Office of Naval Research (ONR)

The Smart Sensor Web Topics are:

- OSD00-SSW01 Sensor Data Collection Management Over a Web by Air Force Wright Lab, Rome, NY (AFRL)
- OSD00-SSW02 Agent-based Visualization by Air Force Wright Lab, Rome NY (AFRL)

- OSD00-SSW03 Semantic/Context Based Data Collection, Management and Visualization by Air Force Wright Lab, Rome, NY (AFRL)
- OSD00-SSW04 Target Tracking with a Distributed Sensor System by Office of Naval Research (ONR)
- OSD00-SSW05 Wireless Surveillance Scalable Sensor Netting by Office of Naval Research (ONR)
- OSD-SSW06 Low Cost implementation of High Density Wireless Networks by Naval Surface Warfare Center, Philadelphia Division (NSWC)
- OSD-SSW07 Wireless Networks for Disaster Control and Bandwidth Augmentation by the Naval Surface Warfare Center, Philadelphia Division (NSWC)
- OSD-SSW08 Hardware Compression of Video Data by the US Army Night Vision Laboratory (NVESD)
- OSD-SSW09 WeatherWeb Sub-Web Meteorological Sensor Array by the Army Research Laboratory (ARL)
- OSD00-SSW10 Unmanned Aerial Vehicle Meteorological Sensing Package by the Naval Research Laboratory (NRL)

The Biomedical Topics are:

- OSD00-HP01 Three-Dimensional Model of Thermoregulation by the Naval Health Research Center (NHRC) Detachment at Brooks Air Force Base, TX
- OSD00-HP02 Enhancing Malaria Vaccine Development by the Naval Medical Research Center (NMRI)
- OSD00-HP03 Functional Genomic Analysis of the Malaria Parasite by the Naval Medical Research Center (NMRI)
- OSD00-HP04 Systems For Improved Red Blood Cell Storage by the Army Medical Research Acquisition Activity (MRMC)
- OSD00-HP05 Blast Mitigation Jacket for Training by the Army Medical Research Acquisition Activity (MRMC)
- OSD00-HP06 Analysis and Interpretation of Real-Time Multi-Parameter Biological Data by the Army Medical Research Acquisition Activity (MRMC)

Three Phase Program

Phase I is to determine, in so far as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months, with a dollar value up to $100,000. We plan to fund 3 Phase I contracts, on average, and down-select to one Phase II contract per topic. This is assuming that the proposals are sufficient in quality to fund. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research and development effort and is expected to produce a well-defined deliverable prototype or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the DoD may award non-SBIR funded follow-on contracts for products or processes, which meet the component mission needs. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The small business is expected to use non-federal capital to pursue private sector applications of the research and development.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in this section.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed Phase I efforts, will be considered. DoD is not obligated to make any awards under Phase I, II, or III. DoD is not responsible for any money expended by the proposer before award of any contract. For specifics regarding the evaluation and award of Phase I or II contracts, please read the front section of this solicitation very carefully, as well as the Component's specific requirements contained in their respective sections. Each of the services and Defense Agencies have developed their own Phase II enhancement policy, which can also be found in theIr respective sections. The DDR&E topics will follows the Phase II enhancement policy corresponding to the topic author's service. That is, the Army laboratories will follow the Army Phase II enhancement policy, the Navy topics will follow the Navy policy, and the Air Force laboratories topics will follow the Air Force policy. (Refer to their respective sections in this solicitation, or their website for details.)

The Fast Track provisions in section 4.0 of this solicitation apply as follows. Under the Fast Track policy, SBIR projects that attract matching cash from an outside investor for their Phase II effort have an opportunity to receive interim funding between Phases I and II, to be evaluated for Phase II under an expedited process, and to be selected for Phase II award provided they meet or exceed the technical thresholds and have met their Phase I technical goals, as discussed Section 4.5. Under the Fast Track Program, a company submits a Fast Track application, including statement of work and cost estimate, within 120 to 180 days of the award of a Phase I contract. Also submitted at this time is a commitment of third party funding for Phase II. Subsequently, the company must submit its Phase I Final Report and its Phase II proposal no later than 210 days after the effective date of Phase I, and must certify, within 45 days of being selected for Phase II award, that all matching funds have been transferred to the company.

Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research and development has commercial potential in the private sector. Proposers who feel that their research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies stated elsewhere in this solicitation.

Contact with DoD

General informational questions pertaining to proposal instructions contained in this solicitation should be directed to the point of contact identified in the topic description section. Proposals should be mailed to the address identified for this purpose in the topic description section. Oral communications with DoD personnel regarding the technical content of this solicitation during the pre-solicitation phase are allowed, however, proposal evaluation is conducted only on the written submittal. Oral communications during the pre-solicitation period should be considered informal, and will not be factored into the selection for award of contracts. Oral communications subsequent to the pre-solicitation period, during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness. Refer to the front section of the solicitation for the exact dates.

Proposal Submission

Proposals shall be submitted in response to a specific topic identified in the following topic description sections. Each topic has a point of contact to which the proposals shall be mailed. The topics listed are the only topics for which proposals will be accepted. Scientific and technical information assistance may be requested by using the DTIC SBIR Interactive Technical Information System (SITIS).

DUSD(S&T) COGNITIVE READINESS TECHNOLOGY FOCUS AREA

The Deputy Under Secretary of Defense for Science and Technology has established a focus area to explore Cognitive Readiness research issues. Cognitive Readiness is ensuring that the warfighter is mentally prepared for accomplishing the mission and is performing at their optimal performance level. Cognitive readiness focuses on optimizing and enhancing the human dimension of U.S. forces. Extended further, the effectiveness of all DoD personnel can be maximized by improvements in cognitive readiness.

Optimization and enhancement of human performance is challenged by many different factors, such as general health issues, mental and physical stress, cultural and societal influences, environmental stressors, adequate education and training. Currently, there are two "core" Department of Defense program areas organized to address Cognitive Readiness issues, the Biomedical and Human Systems programs with subcomponents dealing in health, psychology, sociology, personnel and training, and human factors engineering issues. Of these issues, we have chosen to focus first, and in general, on technologies necessary for the education and training missions of the Department. Specifically, we are examining a focused investment in S&T projects to support the Department's Advanced Distributed Learning strategic plan.

While the emerging technology area of advance distributed learning (ADL) is generically addressed in the core human systems S&T program, the emergence of new information technologies present the opportunity to make significant improvements in training and education effectiveness through ADL technologies. In addition, providing ADL technologies to the DoD enterprise of education and training offers a key opportunity to reduce costs in these domains. In the following section, the Cognitive Readiness topics are described and the Service Laboratory Executive Agents, who will manage the projects, are as follows:

- OSD00-CR01 Automated Dialogue Modeling Using Natural Language Understanding in ADL, by theNaval Air Warfare Center Training Systems Division (NAWCTSD)
- OSD00-CR02 Training Users' Cognitive Readiness for Combat Command Using an Intelligent Tutor to Model Expert Mentor Interactions by the US Army Research Institute (ARI) for the Behavioral and Social Sciences
- OSD00-CR03 A Personal Health and Fitness Assistant by the US Army Medical Research Acquisition Activity (MRMC)
- OSD00-CR04 Digital Resource for Instructional Design in CBT Authoring Environments by the Office of Naval Research (ONR)
- OSD00-CR05 Dismounted C4ISR Data Presentation and Dissemination by the Army Research Laboratory (ARL)
- OSD00-CR06 Enhancing Situation Awareness in Military Operations by the Army Research Institute (ARI), Ft. Benning
- OSD00-CR07 **P**ersonal **E**ducation and **T**raining **A**ssistant for Distance Learning (PETA) by the Naval Air Warfare Center Training Systems Division (NAWCTSD)
- OSD00-CR08 Common Operating Picture for Stability and Support Operations by the Army Research Laboratory (ARL), Ft. Huachuca
- OSD00-CR09 Cognitive Learning Strategies for Medical Skills Training and Sustainment via Distance Learning Means by the Special Operations Command (USSOCOM)
- OSD00-CR10 Computerized Cognitive Assessment Battery by the Office of Naval Research (ONR)

TOPIC NUMBER: OSD00-CR01 TITLE: Automated Dialogue Modeling Using Natural Language Understanding in ADL

MAIL PROPOSALS TO

Bob Seltzer, Code 4.9T
Naval Air Warfare Center Training Systems Division
12350 Research Parkway
Orlando, FL 32826-3224

OBJECTIVE: Investigate and demonstrate the feasibility of methods for automating the development of natural language understanding and human dialogue systems for improving cognitive readiness.

DESCRIPTION: Natural language understanding by computers has been identified as a required technology to develop intelligent computer aided instruction for the emerging field of Advanced Distributed Learning (ADL) in a recent report on the subject by the Deputy Under Secretary of Defense for Science and Technology (DUSD (S&T) office. The report identified the research goal of providing full, natural communication with training and performance support systems in order to direct attention to relevant simulation features in a non-confusing, non-interfering way.

There are basically five main technology areas required to accomplish a human to machine dialog system: speech recognition, natural language understanding (NLU), information retrieval, language generation and speech synthesis. The speech recognition component probabilistically produces candidate sentences where the speech recognition converts audible signals to digital symbols. The recognition of these symbols is processed by language understanding software so that the computer can extract the meaning of spoken words. Language understanding can be accomplished by applying basic grammatical rules to parse the sentence into its parts subject, verb, object and so forth producing a semantic frame. Subsequently, the semantic frame is formatted into a database query to retrieve the desired information. Lastly, the information is formatted through language generation and presented in human understandable speech by a speech synthesizer.

Natural language understanding systems have the challenge of extracting the intended meaning of syntactically correct text input. Simply connecting an existing speech recognition system to an existing natural language processing (NLP) system is not optimal because the speech recognition is a probabilistic system and errors will be propagated to the NLP system. Methods are required to correctly interpret the speech recognition output.

Human dialog systems developed so far are few in number and can deal only with limited domains of knowledge, such as weather forecasts and flight schedules. Further, the methods for their development are not commercially available. Development of a human dialog system requires integration of domain knowledge into multiple technology areas. An investigation of the tools needed to develop the representation of human dialog for the ADL domain would reduce the risk of dialog system development as well as improve the accuracy of a human dialog system due to streamlining of the phraseology and consistency in method.

PHASE I: Investigate current natural language understanding techniques, methods for correctly interpreting a speech recognition output, and techniques for developing human dialogue models for the purpose of Advanced Distributed Learning (ADL). Design a system that employs optimal natural language understanding and human dialogue techniques for use with an ADL application. Prepare a feasibility study report describing the current state-of-the-art in natural language understanding and dialogue modeling. Optimal instructional strategies shall be represented in the solution.

PHASE II: Develop a prototype system based on the design presented in Phase I. The contractor shall demonstrate that the solution can provide intelligent computer aided instruction through the use of natural language dialogue between the instructional system and the student. Further, a tool for automatically developing human dialogue models shall be developed to simplify dialogue system development for any application within the limits of the technology.

PHASE III DUAL USE COMMERCIALIZATION: Provide a commercialized natural language understanding and human dialogue toolset for intelligent instruction. The toolset shall be capable of producing instructional content under the DUSD ADL initiative with the goal of transitioning the technology to that effort. A toolset for producing human dialogue systems using natural language understanding has potential applications in any field where a human machine interface using a personal computer can be employed for training, instruction, and \or database query.

REFERENCES:

1) Zue, V., “Talking with Your Computer”, Spoken Language Systems at Massachusetts Institute of Technology (MIT), Cambridge MA, published in Scientific American, August 1999
Website-> http://www.sls.lcs.mit.edu/sls/news/index.html#NEWS
2) Dowding, Gawron, Appelt, Bear, Cherny, Moore, Moran, “Gemini: A Natural Language System For Spoken Language Understanding”, SRI International

3) Dougherty, R. C., “Natural Language Processing-A Generative Grammar in Prolog”, Linguistics Department -New York University (NYU), Lawrence Erlbaum Associates, Inc. 1994.
Website-> http://www.nyu.edu/pages/linguistics/ling.html
4) Cole R., Mariani J., Uszkoreit H., Zaenen A., Zue V., “Survey of the State of the Art in Human Language Technology”, Sponsored by the National Science Foundation (NSF), Published by Center For Spoken Language Understanding at Oregon Graduate Institute of Technology,1996 Website-> http://cslu.cse.ogi.edu/HLTsurvey/HLTsurvey.html
5) Wauchope, K., “Eucalyptus: Integrating Natural Language Input with a Graphical User Interface”, NRL, Feb 1994, report # NRL/FR/5510-94-9711
6) Holland V.M., Kaplan J.D., Sams M.R., “Intelligent Language Tutors”, U.S. Army Research Institute Website-> http://www.erlbaum.com/html/1144.htm
7) Advanced Distributed Learning Network, Website-> http://www.adlnet.org/

Key Words: natural language understanding; advanced distributed learning; speech recognition; learning, intelligent computer aided instruction, human dialogue system.

TOPIC NUMBER: OSD00-CR02 TITLE: Training Users’ Cognitive Readiness For Combat Command Using An Intelligent Tutor To Model Expert Mentor Interactions

MAIL ALL PROPOSALS TO
U.S. Army Research Institute
Attn: Jonathan Kaplan
5001 Eisenhower Avenue
Alexandria, VA 22333-5600

DOD CRITICAL TECHNOLOGY: Manpower, Personnel and Training; Computing and Software; Creating Instructor Models in Intelligent Tutors Based on Theory

ARMY TECHNOLOGY AREA: A-08

OBJECTIVES:
1. Develop and demonstrate a dynamic intelligent tutor to improve military officers’ battlefield thinking skills via a set of interactive battlefield situations. 2. Conduct a training effectiveness assessment.

DESCRIPTION: The Army Research Institute (ARI) is involved in developing and testing a concept for teaching battlefield command reasoning that involves deliberate practice specifically designed to improve thinking performance. Based on the theoretical and experimental work of K.A. Ericsson and others[1], deliberate practice involves placing the learner repeatedly in a variety of situations that require the same skill sets until those skills are applied both flexibly and automatically. In ARI’s application, called *Think Like a Commander*, we are attempting to ingrain a set of battlefield thinking habits that are applicable across a wide range of tactical situations. Some of these habits we use are: model a thinking enemy, use all available assets, and consider how your fight fits into the bigger picture from friendly and enemy perspectives, and others. ARI research has found that these behaviors are characteristic of expert tactical thinkers, but in less skilled and experienced tacticians these behaviors, though well understood conceptually, are often absent during realistic tactical problem solving. This is especially true in the demanding conditions of performing as commander. Thus this set forms a set of skills appropriate for training, The concepts described above have been tested at the Command and General Staff College (CGSC) at Fort Leavenworth during the 1999 Army Experiment 6 digital training experiment. Currently, training modules of Think Like a Commander are being developed for use with Brigade Command designees attending the School for Command Preparation of CGSC and will be used in that course in 2000.

In its current form, *Think Like a Commander* presents tactical situations to an individual and requires the learner to perform reasoning, reach conclusions, and make decisions. If the learner fails to take any of the applicable themes into account in a presented tactical situation, they are asked indirect questions, by a live expert acting as tutor (or mentor), intended to get them to think about the theme. If they fail to respond adequately, the questioning becomes more direct. Additional feedback is also provided.

To make this training cost-effective for use with large numbers of officers as an application of advanced distributed learning, the mentor’s role needs to be incorporated into an intelligent tutor. The system would be packaged in web-based or other digital format, that can be exported and used by individual officers for interactive self-training. We are looking for a contractor with intelligent tutor experience. The research involves testing to determine whether an intelligent tutor can be adapted to a highly complex and dynamic situation that incorporates expertise of a high degree. Construction of the intelligent tutor involves developing interaction strategies to support dialogue between the modeled expert and the learner. The user interactions provide the basis whereby the user’s strengths and weakness with regard to the skills can be diagnosed by the tutor and tailored feedback provided.

PHASE I: In Phase I of the SBIR the contractor would identify possible interaction strategies. A small demonstration program based on one of our training scenarios would be developed as proof of applicability of the intelligent tutor.

PHASE II: In Phase II, the contractor would construct a prototype system by enlarging the range of existing scenarios. The prototype tutor would assess the student's proficiency in the identified set of skills. A training effectiveness assessment would be conducted.

PHASE III DUAL USE COMMERCIALIZATION: This SBIR has strong commercialization potential. Currently, intelligent tutors have been most successful in areas where knowledge and problems are well-structured and based on well-defined rule sets. The application involves extension of the technology through innovative methods. The contractor can expect strong support because of the great amount of preparatory work that has been done. A successful solution opens applications in industrial, academic, medical, legal, and governmental markets, as well as a wide variety of other fields, where expert mentoring predominates.

REFERENCES
1. Ericsson, K.A., Krampe, R., & Tesch-Romer, C. (1993) *The Role of Deliberate Practice in the Acquisition of Expert Performance*, Psychological Review, V:l 100. No. 3, p. 366.
2. Deckert, J.C., Entin, E.B., Entin, E.E., MacMillan, J. & Serfaty, D. (1996). *Military Command Decision Making Expertise: Final Report.* (Research Note 96-16). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A306 801).
3. Advanced Distributed Learning Network, Website-> http://www.adlnet.org/

TOPIC NUMBER: OSD00-CR03 TITLE: A Personal Health and Fitness Assistant

DOD CRITICAL TECHNOLOGY: Biomedical

DUSD(S&T) FOCUS AREA: Cognitive Readiness

MAIL ALL PROPOSALS TO
US Army Medical Research Acquisition Activity
MCMR-AAU (Herman Willis)
820 Chandler Street
Ft. Detrick, MD 21702-5014

OBJECTIVE: The objective of this project is to provide individual service members with easily accessible, tailored guidance concerning their personal fitness for duty and deployment.

DESCRIPTION: The awardee will develop and demonstrate a prototype, internet-based system. Although internet linkages and specific items of content will be available from the Department of Defense, the contractor will assume the challenge of creating an attractive, balanced, imaginative package of instruction and interactive aides for maintenance of personal fitness. Instruction and interactive aides must include diet, weight control and exercise. Other areas to be considered for inclusion in system components are Body Mass Index, immunizations, self-administered diet supplements/drugs, cardiovascular risk, warning signs concerning unhealthy habits, injury avoidance, sleep, stress assessment and stress management, access to services for self and family members, and other matters directly related to service member well-being .

To the fullest extent possible, the contractor will design an interactive site in which user-entered information (age, gender, military assignment, geographic location, family data, daily exercise logs, daily dietary logs etc.) shapes the feedback provided. Commercial data (e.g., nutrition tables of common foods) may be used with DOD approval. The contractor is encouraged to make maximum use of Internet, educational, and other strategies that will sustain independent, long-term use of the site by service members of all ranks. The contractor will carefully assess concerns for privacy in designing the site and will insure that the educational system conforms with the DoD Advanced Distributed Learning (ADL) Initiative's Sharable Courseware Reference Model (SCORM) specification.

The prototype system will be established on the awardee's Internet server, but will be platform independent and fully compatible with DOD Internet and intranet systems.

PHASE I: The awardee will develop overall system architecture, a detailed outline of proposed content and linkages, a research plan for validation of system educational value and personal training value, the general approach toward for encouraging independent use of the site, and identify a test population in consultation with the DOD.

PHASE II: The awardee will complete development of the prototype system and site, present the research results of the initial validation of the system, will carefully assess concerns for privacy in designing the site and will insure that the educational system conforms with the DoD Advanced Distributed Learning (ADL) Initiative's Sharable Courseware Reference Model (SCORM) specification. The contractor will evaluate the site for no less than nine months.

PHASE III DUAL USE APPLICATIONS: Such an internet technology-based system could be a highly marketable to the domestic health care system (e.g., HMOs) and other government and private organizations concerned with delivering health care and preventive medicine to large, diverse populations.

OPERATING COST AND SUPPORT REDUCTIONS: Problems with individual weight control and general physical fitness cost the DoD millions of dollars each year from the operations and health care O&M accounts. This cost should be significantly reduced if there is generally available a system that enables each individual service member the opportunity to manage their physical fitness for duty and/or to alter their personal habits to maintain optimum fitness.

KEYWORDS: personal health, fitness, education

REFERENCES: http://www.adlnet.org/

TOPIC NUMBER: OSD00-CR04 TITLE: Digital Resource for Instructional Design in CBT Authoring Environments

DoD CRITICAL TECHNOLOGY: Advanced Distributed Learning

MAIL ALL PROPOSALS TO
Susan F. Chipman, Ph.D.
Office of Naval Research, Code 342
800 N. Quincy Street
Arlington, VA 22217-5660

OBJECTIVE: Develop a digital resource of instructional design information that can run in parallel with existing commercial authoring tools that support the development of computer based and/or web based training.

DESCRIPTION: In military environments, subject-matter experts who are not trained in instructional design are often assigned to develop or significantly revise computer-based training. Authoring tool environments for CBT development support and facilitate the work of courseware authors who know what they want to do. Typically, however, they provide little help in the instructional design task. Consequently, much of what we know about the effective design of instruction is not implemented in actual military training. It would be helpful to have an digital resource for instructional design advice that can run in parallel to a variety of authoring tool environments and provide on-demand advice for particular instructional design problems as they arise in the process of authoring. The development of a useful resource of this kind will require research on the instructional development process of authors in the target audience as well as investigation of the terms/words they are likely to use in describing the problems they confront because they are unlikely to be familiar with the terminology of professional instructional designers. In addition to abstract, verbal guidelines, the resource should provide illustrative examples of instruction consistent with the advice being given.

PHASE I: Review previous efforts and existing literature on the actual processes of instructional or CBT authoring, to provide instructional design advice to CBT authors. Conduct small scale study of authoring processes of target audience of subject matter experts attempting to author CBT without instructional design expertise or training to determine the kinds of instructional design questions they raise. Develop a taxonomy for the instructional design guidelines or advice contained in resources such as those cited here. Propose a prototype design for the desired digital resource and proposed methods for conducting the research outlined in Phase II.

PHASE II: Build a prototype of the proposed digital resource. Conduct research to develop appropriate labeling and information retrieval techniques to access the appropriate instructional design guidelines or advice to the CBT author as needed, in the process of authoring. Conduct an experimental evaluation of the usability and value of the digital resource. Revise system as suggested by results.

PHASE III: DUAL-USE COMMERCIALIZATION: In collaboration with one or more of the publishers of commercial authoring tools for CBT, develop the digital instructional design resource into a viable commercial product.

REFERENCES:

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2. Merrill, M.D. (1994) Instructional Design Theory. Englewood Cliffs, NJ: Educational Technology Publications.
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5. Wetzel, C.D.; Radtke, P.H.; Stern, H.W. (1994) Instructional Effectiveness of Video Media. Hillsdale, NJ: Lawrence Erlbaum Associates.
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7. Hickey, A.E.; Spector, J.M.; Muraida, D.J. (1991) Specifications for an Advanced Instructional Design Advisor (AIDA) for Computer-Based Training. DTIC AD Number: ADA237255.
8. Montague, W.E.; Knirk, F.G. (1993) What Works in Adult Instruction: The Management, Design and Delivery of Instruction. DTIC AD Number: ADA266344
9. Schneider, W. (1985) Training high performance skills: Fallacies and Guidelines. Human Factors, 27,285-300.
10. Merrill, M.D. (1984) Don't bother me with instructional design: I'm busy programming! Los Angeles: Center for the Study of Evaluation, University of California.
11. Dempster, F.N. (1988) The spacing effect: A case study in the failure to apply the results of psychological research. American Psychologist, 43, 627-634.
12. Baggett, P. & Ehrenfeucht, A. How an unfamiliar thing should be called. Journal of Psycholinguistic Research, 11, 437-445.

KEYWORDS: computer-based training, web based training, instructional design, authoring tools, advanced distributed learning.

TOPIC NUMBER: OSD00-CR05 TITLE: Dismounted C4ISR Data Presentation and Dissemination

MAIL ALL PROPOSALS TO

John P Grills
US Army Research Lab
ATTN: AMSRL-IS (Mr. John Grills)
2800 Powder Mill Rd
Adelphi, MD 20783

OBJECTIVE: Develop Innovative Presentation and Dissemination Methods for 2D/3D C4ISR Information to an Infantry Soldier, in a distributed, collaborative environment.

DESCRIPTION: Most current Command, Control, Communication, Computers and Intelligence Surveillance and Reconnaissance (C4ISR) system's capabilities reside within Tactical Operations Center (TOC) environments. Producing information presentations of critical data for easy assimilation at lower echelons is always difficult. The lack of high-end automation (expensive computers) at the unit level (foot soldiers) makes the task even more difficult. Presenting information/knowledge to lower echelons through inherently familiar multimedia presentation techniques on low cost devices could greatly reduce the difficulty. Current state-of-the-art personal gaming platforms (i.e.: Playstation/Nintendo) have 64bit hardware graphics engines. The next generation platforms, scheduled to be released in 4Q 2000 will be based on 128bit hardware engines. This particular industry relies on volume and profits from Game revenues (software) to offset the low cost of the playback devices that are, in effect, loss leaders.

Innovative and intuitive data visualization techniques in a communications constrained environment are required. This will include unique methods to efficiently (from a computer graphics standpoint) represent dynamic objects in a high fidelity, geo-specific immersive environment. Currently, the dynamic objects in a gaming environment are tailored to be realistic to the user, but also computationally efficient to the hardware. The user interfaces to these gaming environments also tend to be very intuitive in order to insure broad market acceptance. Cognitive research combined with software implementation will provide the ability for lower level units to reachback and query subject matter experts and analysts at higher echelons, who will respond with appropriate tailored information. In effect, this will allow dispersed operators a powerful data-mining interface. This approach would greatly enhance cross echelon collaboration, small unit rehearsal capability, and situational awareness on the battlefield. It is also an economical method to equip soldiers with automation and rehearsal systems, which require no special training to use.

PHASE I: Review current state of the art in gaming hardware and software development environments to determine which might be best suited for use by the military. The development environments must be capable of concurrently supporting terrain specific, nonrepeating texture maps, and complex dynamic objects. Deliveries to include: high level architectural analysis of at least two major commercial gaming environments; risk assessment of associated development in each of these environments; functional assessment of multi-user (player) environment communications mechanisms.

PHASE II: Develop initial prototype software, which runs on the most advanced gaming platform available. The ‘Game’ will include geo-specific terrain imagery of at least 10-meter resolution. This prototype development will serve as a tool to determine how best to approach the dynamic object representation. Utilize existing landline communication infrastructure (Static IP) for object location updates (tracks) and reachback query mechanisms to web-based information services (Command & Control Track Database). Develop realistic and efficient data structures to represent dynamic objects (other players, vehicles etc), while minimizing external bandwidth requirements. Develop a methodology and automation architecture to essentially develop these geo-specific training ‘games’ on an as-needed basis, with short product cycle times.

PHASE III: DUAL USE APPLICATIONS: Police, Firefighting, Emergency Medical Services, Homeland/Civil Defense applications seem to be almost closely linked to the unit level military operational environment. This is especially true in this day and age of contingency operations in complex environments (MOUT, Military Operations in Urban Terrain). Industry is proceeding down a path which will produce platforms for the ever-expanding gaming market. 'Computer Appliances' is another area which continues to expand (i.e., Cell Phones with PDA capabilities). This genre of products will provide the volume driven market, which insures the technology required will continue to progress at a rapid pace. The Army would be wise to investigate this market, and use it to its advantage. This is almost a reverse application of the dual-use concept. The ability to generate and present geo-specific immersive environments for use in multiple-user training environments is not a new concept (SIMNET). The ability to do this in a commercially accepted ‘standard’ gaming environment, at a cost of $100/user, is quite attractive.

OPERATING AND SUPPORT COST REDUCTION: Very little user-level training will be required, due to the enormous popularity of the proposed dissemination platforms. Proposed user devices are not only intuitive but are cost/performance leaders in the commercial marketplace.

KEYWORDS: C4ISR, Unit Level Situational Awareness, Collaboration, Small Unit Rehearsal, Cognitive Readiness, Data Mining, Data Visualization, Gaming Devices

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TOPIC NUMBER: OSD00-CR06 TITLE: Enhancing Situation Awareness in Military Operations

DOD CRITICAL TECHNOLOGY: Manpower, Personnel and Training.

MAIL ALL PROPOSALS TO
U.S. Army Research Institute
Attn: Jonathan Kaplan
5001 Eisenhower Avenue
Alexandria, VA 22333-5600

OBJECTIVE: Develop and validate methodologies for enhancing individual situation awareness (SA) for leaders of military operations. The methods should result in improved tactical decision-making in highly challenging operational scenarios and address the full gamut of cognitive processes involved in SA, including perception, working and long-term memory, attentional resources, and task allocation. The methods should lead to expert levels of SA performance in perceiving critical SA elements, comprehending their importance, and projecting likely future battle outcomes. Thus, the methods should be adaptive and progressive in the difficulty level of scenarios and tasks presented.

DESCRIPTION: Situation awareness is the ability to maintain a constant, clear mental "picture" of the tactical situation and the ability to use that information as the basis sound decisions. Recent and on-going digitization efforts in the military have led to a dramatic increase in the amount and speed of battlefield information being presented to leaders at all echelons of the ground battle. It is imperative that leaders have the necessary cognitive skills to leverage that information into improved and more rapid decisions. The core SA enhancement issues include rate of acquisition of proficient SA, retention of SA skills, and maintenance or reacquisition of SA skills.

PHASE I: The initial effort should describe and evaluate alternative training methods for establishing, maintaining, and enhancing SA skills. The basic cognitive skills needed for high SA in ground warfare were identified by Endsley et al (2000), who developed a model of SA specifically tailored to the challenges of ground forces. According to this model, the cognitive substrate of SA includes attention, memory (working and long-term), perception, and spatial skills. Related processes of pattern matching, goal driven processing, and automaticity are also critical. Endsley et al. also describes a number of SA measurement approaches. Those most relevant to the proposed effort include on-line queries and the situation awareness global assessment technique (SAGAT). Phase I research should develop a plan for measuring the cognitive components of SA. In addition, it should develop strategies to assess overall SA, using Endsley et al's suggestions or other measurement approaches deemed to be appropriate. The effort should also address who will benefit most from this training, e.g., low, middle, or high percentile performers. A plan for training these cognitive skills and global SA should be detailed. In summary, the Phase I effort should describe SA training procedures that can be used to assess and improve cognitive and SA performance for ground-force leaders. This work will be documented in a research report.

PHASE II: A battery of tests will be designed to assess skills in areas critical to SA. This training strategy will be validated using procedures identified in Phase I. Specifically; the training procedures will explore variables affecting the acquisition, enhancement, and retention of SA and SA-related basic cognitive skills. Measures that are sensitive to key cognitive processes and situational cues are to be tested. This information may then be used to further refine the SA training methodologies into a format suitable for unit or home station training. The final product should provide a basis for training requisite cognitive skills and SA needed for a specific mission, e.g., urbanized combat. There will be a research report to describe the background, methods, results, and implications of the study.

PHASE III DUAL USE APPLICATIONS: The development of advanced information technology is rampant throughout the private and public sector. Managers and workers alike must perceive, process, and react to vast quantities of information rapidly and accurately. The SA training methodologies will provide a model for how to teach and enhance SA skills and should generalize to a variety of business and industrial settings.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Improving SA skills will make military units more responsive and able to achieve objectives more quickly with fewer personnel, less fratricide, and more efficient use of resources. By improving the effectiveness of fighting and support units, it serves as a force multiplier.

KEYWORDS: Situation (al) awareness, information technology, digitization, and training.

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TOPIC NUMBER: OSD00-CR07 TITLE: Personal Education and Training Assistant for Distance Learning (PETA)

MAIL ALL PROPOSALS TO

Robert M. Seltzer
NAWCTSD, 4.9T
12350 Research Parkway
Orlando, FL 32826-3275

OBJECTIVE: The purpose of this SBIR will be to explore concepts, and to design and develop an intelligent interface agent that provides counseling, pedagogical information, scheduling, testing, performance feedback, and learning management services for individual trainees who utilize the distance learning (DL) capabilities of military distance learning networks. The project may utilize findings from current research and development on intelligent interface agents used in a variety of training simulations and other computer-based training applications (e.g., Angros, Johnson, & Rickel, 1997; Johnson, Shaw, & Ganeshan, 1998; Knode & Knode, 1998), or develop new paradigms and metaphors for the personal learning assistant. Desired agent capabilities include: compatibility with DoD networks (i.e., compliance with the Shareable Courseware Object Reference Model [SCO-RM]), reasonable pedagogy, user selectable interface, scalability, open architecture, modularity, voice interaction, adaptive, embodiment (i.e., a physical representation of the agent to improve interactions with the trainee), and transportability.

DESCRIPTION: The Navy, Army, Air Force and Marine Corps must train their personnel to high levels of skills and knowledge to deal with increasingly complex weapon systems and wider ranges of missions. Distance learning (DL) has been identified as an instructional tool that can significantly contribute to this goal in *The Navy-Wide Distributed Learning Planning Strategy* (Director of Naval Training, 7 December, 1998). It has also been identified as an instructional tool that can significantly contribute to improved training in the Marine Corps Multimedia Infrastructure Mission Needs Statement (MNS) number TNG 1.23 dated 04 August 1994. "The MNS identified a significant shortfall in the development, distribution, and management of resident and DL throughout the Marine Corps" (*Operational Requirements Document*, 1999, p. 3). The MNS focuses on the hardware and software necessary to make course materials "accessible, to Marines via the network, 24 hours per day, seven days per week, and 365 days per year" (ORD, 1999, p. 4). The other services and DoD are also strong advocates of DL (see for example: The *Air Force Distance Learning (DL) Roadmap*, Air Force Modernization Planning, 17 August 1999; the *Total Army Distance Learning Program*, 7 October 1997; and the *Department of Defense Strategic Plan for Advanced Distributed Learning*, 30 April 1999). Once DL networks are established, innovative methods will be required to schedule, monitor, assist, and provide performance feedback to individual trainees in DL. One-on-one tutoring has long been recognized as the most effective method of instruction (Bloom, 1984). This attribution is so strong that a 1997 report from the National Academy of Sciences (under ONR Contract N00014-96-D-0169/0001) stated that "In military training… a single instructor for every student is an instructional necessity and an economic impossibility" (p. 7). This same report went on to suggest that one method for achieving this goal is to develop "instructional intelligence" using "Intelligent agents" (p. 17). The use of an intelligent agent as a personal learning assistant will optimize learning in DL by making it more interesting through the tailoring of the instruction to the needs of each trainee, and by incorporating effective instructional methods (pedagogy) in the training materials.

PHASE I: Explore alternative approaches, architectures, and feasibility concepts for the use of intelligent agents as personal learning assistants in DL. The contractor shall formulate detailed plans for 1) building a prototype personal learning assistant for a DoD DL application and 2) for testing its effectiveness. The plans for the prototype shall provide justification for the chosen training task based upon an in-depth understanding of Navy, Marine Corps, Air Force, Army, or DoD DL requirements. It shall be capable of installation on an existing DoD DL network (e.g., Navy ADL, Marine Net, Total Army Distance Learning Program, or the DoD ADL Co-Laboratory). The plans for prototype development shall also include methods to ensure compliance with DoD SCO-RM requirements.

PHASE II: Following the plans formulated during Phase I, the contractor shall provide a more detailed analysis of the specific context for intelligent agent development and implementation. The contractor shall then develop, test, and demonstrate the prototype personal learning assistant. The contractor shall compare the performance of DL trainees assisted by a personal instructional agent to the performance of DL trainees without such assistance.

PHASE III DUAL USE COMMERCIALIZATION: The contractor shall produce a technology demonstration based on the prototype system developed under Phase II. This technology demonstration will consist of a full-scale DL curriculum and will be evaluated at a DoD training facility. There are many potential applications for personal instructional assistants within and outside the military. Many commercial organizations are using DL to train their personnel in a wide variety of tasks. Once intelligent agents have been shown to improve the effectiveness of DL, they will quickly be incorporated into many DL applications.

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KEY WORDS: distance learning; training; intelligent agent; training management

TOPIC NUMBER: OSD00-CR08 TITLE: Common Operating Picture for Stability and Support Operations

DOD CRITICAL TECHNOLOGY: Human Systems--Information Display and Performance Enhancement

TECHNOLOGY AREA: A-8 Life, Medical, and Behavioral Sciences

MAIL ALL PROPOSALS TO
US Army Research Laboratory
Ft. Huachuca Field Element
ATTN: AMSRL-HR-MY (BARNES)
Greely Hall (Blgd. 61801), Rm. 2631
Ft. Huachuca, AZ 85613-5000

TRADOC/BATTLE LAB INTEREST: Prototype Brigade; Depth & Simultaneous Attack BL; Battle CMD Battle Lab-Leavenworth and Huachuca

OBJECTIVE: To support Cognitive Readiness through enhancement of situational awareness and decisionmaking ability for commander and staff in peacekeeping or in force-on-force conditions involving significant support and stability operations (SASO)(Draft FM 100-20). The research goal is to develop a semantically-rich abstract visualization environment that allows a commander and staff to quickly and easily represent, manipulate and understand SASO environments such as Somalia, Kosovo and Bosnia peacekeeping (Olsen & Davis, 1999).

DESCRIPTION: The Army is currently investing in the development of the Initial Brigade, in development of Common Operational Picture (COP) technology for future operations, and in new doctrine for SASO (Draft FM-100-20.). The Defense Information Systems Agency has developed software requirements for development of COP technology (DISA draft document 415-98). However, observations of experimentation in emerging new Army organizations (Future Fires Command and Control) indicate that COP advances are not addressing the role of SASO visualization for situation assessment, force protection, and decision making. (Baxter, 1999). The problems of SASO missions such as Kosovo are unique and require more adaptable software environments and new visualization, symbology and decision aiding concepts (Olsen & Davis, 1999; Taw & Peters, 1995). This effort would investigate SASO visualization requirements and use cognitive engineering approaches to develop a software environment that addresses commander's unique requirements for SASO operations. Examples of the type of representations would include networks of adversarial groups, possible sabotage or ambush points, neighborhood compositions, 3-D animated walk-through street maps, and hyperlinks showing group relations and changing alliances. The final product would include both cognitive research and the development of a visualization environment that extends the commander's ability to "see" the unfolding problem space defining particular SASO situations and be adaptable enough to be useful in a wide variety of such situations. Such a system must contain the ability to easily construct visualization models that capture the dynamics of the entities in this space and be able to "spotlight " patterns and display possible outcomes resulting from these dynamics. This environment must be compatible with low bandwidth, cognitive simplicity, and portability requirements (preferably a laptop or suitcase configuration). The cognitive visualization research must address: level of abstraction, human acceptance of solutions from intelligent algorithms, display of uncertain consequences and the human performance characteristics of the display formats in both single workstation and collaborative configurations. (Barnes, 1997; Barnes & Wickens, 1997, 2000; Parasuraman and Riley, 1997; Wickens & Hollands, 1999).

PHASE I: Develop a cognitive task analysis of past SASO environments using at least three case studies showing both urban and rural contingencies. Based on this study, develop a taxonomy of visualization requirements and proposed aids to address these requirements. Develop and selectively demonstrate a general software visualization architecture to satisfy these requirements that is generic enough to be used in a variety of potential SASO situations. Finally, develop an evaluation plan that addresses the important cognitive dimensions of situation awareness, decision making and problem solving for SASO scenarios(Wickens & Hollands,1999).

PHASE II: Develop a working prototype that demonstrates the full range of visualization tools proposed in phase I. Perform Soldier performance experiments as per evaluation plan to validate the tool's efficacy in enhancing overall situation awareness and decision making (e.g., Endsley, 1995). The models, resulting visualization concepts, and hardware supporting them will be evaluated as to their level of abstraction, adaptability, portability, cost and operational usefulness for SASO.

PHASE III DUAL USE APPLICATIONS: Commercial development of the visualization tools for civilian law enforcement tasks such as monitoring gang activities, patrolling urban areas, riot control, etc. Other uses would be for drug interdiction and border incursion problems and disaster management where there is widespread dislocation and break down of normal civilian infrastructure.

OPERATING AND SUPPORT COST (OSR) REDUCTION: The criteria for the proposed system require it to be demonstrably intuitive and displayed on a portable PC or integrated into an ATTCS environment. A successful system should reduce costs for equipment, training, and maintenance.

KEYWORDS: COP; SASO; visualization; cognitive adaptability; collaboration

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TOPIC NUMBER: OSD00-CR09 TITLE: Cognitive Learning Strategies for Medical Skills Training and Sustainment via Distance Learning Means

MAIL PROPOSALS TO

US Special Operations Command
ATTN: SOAL-K (Mr. J. Sam Thompson)
7701 Tampa Pt. Boulevard
MacDill AFB, FL 33621-5323

OBJECTIVE: Develop and apply cognitive learning strategies and algorithms to distributed learning for initial and sustainment medical training allowing training resources to be conserved while still ensuring that learning objectives are met.

DESCRIPTION: The internet provides a convenient means for delivering training products to distributed locations, and is ideal for military training programs that must train many people at disparate locations to a common standard. Providers of web-based distance learning programs are taking advantage of evolving features and technologies to improve the presentation and ease-of-use of their products (e.g., multimedia content and HTML/XML). Yet, the majority of resources appear to be going towards making the products look good and function better, rather than ensure the training material gets into and stays in the student's head. Cognitive learning strategies and algorithms hold the promise of solving this problem, [1] and need to be applied to the design and packaging of distance learning training materials so that they are optimized both in terms of the means of delivery (i.e., the internet), and the training target (i.e., the human brain).

An excellent and pressing case for a revolution in training affairs is military medicine. Military medical personnel must be prepared to deliver an ever-increasing range of medical services in both peace- and wartime. These services need to be available even in extreme environmental conditions, regardless of equipment limitations, and often without supporting medical infrastructure or evacuation resources common to civilian medicine. Military medical personnel and combat lifesaver training programs have been designed and implemented to provide the skills and tools necessary to meet these demands. However, at the same time medical training requirements are on the increase, personnel numbers and training time are severely constrained. To cope with this situation the Department of Defense (DOD) needs innovative training technologies that simultaneously improve the speed, effectiveness, and portability of medical education. Specifically, DOD needs to bring cognitive learning principles, strategies, and algorithms to bear on military medical education materials for delivery via the Internet.

The United States Special Operations Command (USSOCOM), through its Joint Special Operations Medical Training Center (JSOMTC) at Fort Bragg, NC, provides a focused and intense military medical training program for Special Operations Forces (SOF), i.e., Navy SEAL corpsmen, Special Forces and Ranger Medics, and Air Force Para-rescuemen. While the concentration is on special operations- unique medical situations and operating environments, the training is applicable to other military and civilian medical personnel. There are several areas of JSOMTC training that lend themselves to implementation via distance learning means, to include:

a. Pre-JSOMTC training to provide a common level-of-expertise in pre-requisite requirements. Examples would be medical terminology and medical math. Distance learning would be a significant enabler here, since pre-requisite expertise could be obtained while personnel were engaged in other training or operations. Self-directed training at JSOMTC. Training remediation and refresher training would be accomplished at JSOMTC, but off-line from regular classes and at the student's own pace. As much as 30% of each of the classes taught at the JSOMTC have to be recycled because of inability to meet the training standards. Self-paced, computer-based instruction could help to both reduce this recycle rate and maximize the medical education of these students while they are in an "out-of-training" status.

b. Post-JSOMTC training. It is costly and difficult, given present operational demands, for SOF medical personnel to return to the JSOMTC for refresher training or to learn new skills. A common training experience is essential to consistency of skills and managing certification requirements (i.e., SOF medical personnel must maintain Emergency Medical Technician – Paramedic certification). Distance learning could solve this problem.

Analysis of available and emerging distance learning resources recently conducted by USSOCOM has reinforced that efficient means of distance learning training are proliferating. But no matched, focused, content is currently available to take true advantage of these means.[2] Consequently, USSOCOM is interested in how medical training materials can be designed, or redesigned/reorganized for more active, immersive, and retentive learning, while, at the same time becoming more deployable via net-based approaches.

PHASE I: Review JSOMTC (or equivalent commercial or military) medical training packages and SOF medical personnel training requirements and cognitive abilities to identify candidate areas and means for adaptation to cognitive learning strategies in a net-based product. Demonstrate the feasibility of such a product/approach via analysis of quantitative data, simulation, or, if necessary, limited testing within the Phase. Make recommendations for a prototype to demonstrate in Phase II.

PHASE II: Based on Phase I design/redesign selected training package(s) into a prototype that will demonstrate effectiveness and cost/benefits for military and dual/use applications.

PHASE III DUAL USE COMMERCIALIZATION POTENTIAL: Although the form and format of medical training materials used at the JSOMTC are unique to SOF, most of their content is not. There are many applications across DOD and outside DOD that can take advantage of training packages designed for the JSOMTC. Examples include the conventional Army[3] and the Wilderness Medical Society[4], who have already developed training based on SOF combat casualty care procedures. Advancements in deployable health care training efficiency and effectiveness would have wide-ranging application to Health Management Organizations, Hospitals, and Emergency Medical Technician training certification programs. But this topic is really about a significant but general advancement in learning methodologies, particularly deployable and net-based learning tools that represents an emerging and growing market, that actually improve comprehension and retention, and these would have application across government, industry, academia, and the population at-large.

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TOPIC NUMBER: OSD00-CR10 TITLE: Cognitive Assessment Battery

MAIL ALL PROPOSALS TO
Name: Susan F. Chipman, Ph.D.
Office of Naval Research, Code 342
800 N. Quincy Street
Arlington, VA 22217-5660

CATEGORY: applied research.

SCIENCE/TECHNOLOGY AREA: Cognitive Readiness

TITLE: Computerized Cognitive Assessment Battery

OBJECTIVE: To develop a theoretically defensible, comprehensive test battery for assessing all important aspects of cognitive function in situations where cognitive function may have been compromised by unknown disease or chemical agents, stress or fatigue.

DESCRIPTION: To better understand the impact of variables such as food and sleep deprivation and stressful experiences, as well chemical exposures and disease processes, on cognitive readiness, a comprehensive test battery assessing all significant aspects of cognitive function is needed. Current test batteries used for this purpose reflect the haphazard growth of cognitive research, in which some aspects of cognition have been intensively investigated and others neglected. Typically, cognitive task samples from the intensively investigated areas are used to make up a battery, without any assurance of comprehensive coverage. In recent years, cognitive psychologists and scientists have begun to develop unified theories of cognition that can potentially provide a theoretical foundation for selecting tasks to provide a comprehensive assessment of cognitive functioning. Recent research has also shed light on newly recognized aspects of cognition, such as diverse forms of working memory.

PHASE I: Review prior efforts to produce computerized cognitive test batteries for such purposes. Prepare a report critiquing past efforts in terms of theoretical rationales and gaps in comprehensive coverage. Review recent literature in cognitive psychology, cognitive science and cognitive neuroscience to develop specifications for a truly representative test battery that would assess all important aspects of cognitive function. Identify experimental tasks from the research literature that are candidates for tests to be included in the comprehensive test battery. Design research that would evaluate these tasks and select among them to yield the desired comprehensive cognitive test battery.

PHASE II: Execute the research plan developed in Phase I and demonstrate the sensitivity of the battery in some DoD relevant domain, such as the assessment of the cognitive effects of the extreme stress and fatigue involved in Army Ranger training.

PHASE III COMMERCIALIZATION POTENTIAL: Demonstrate and market the battery for a range of other applications, such as the assessment of cognitive effects of aging, HIV infection, Pfisteria exposure, motion sickness, etc. The need for a comprehensive cognitive assessment battery arises in many contexts. For example, one of the earliest computerized batteries was sponsored by the Environmental Protection Agency, to screen populations of workers for evidence of adverse cognitive effects of exposure to industrial chemicals.

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KEY WORDS: Cognition, cognitive performance, cognitive assessment battery, neuropsychological assessment, stress, fatigue, neurotoxicity, readiness

DUSD(S&T) SMART SENSOR WEB TECHNOLOGY FOCUS AREA

The Deputy Under Secretary of Defense for Science and Technology has established a focus area to explore Smart Sensor Web research issues. Smart Sensor Web (SSW) is a recent focus inspired by extraordinary technological advances in sensors and microelectronics and by the emergence of the Internet as a real-time communication tool. The near future will see a proliferation of sensors and associated processors available for battlefield use. Commercial and military space technology and systems will provide major leaps in coverage, timeliness, and resolution. Many efforts in these areas are ongoing in the Services and Agencies, and together could provide a tremendous new warfighting capability. The overall vision for SSW is an intelligent, secure, web-centric distribution and fusion of sensor information that provides greatly enhanced situational awareness, on demand, to Warfighters at lower echelons.

We have chosen the following topics and Service Laboratory Executive Agents to manage the SBIR topics in this technology area:

- OSD00-SSW01 Sensor Data Collection Management Over a Web by the Air Force Wright Laboratory, Rome, NY
- OSD00-SSW02 Agent-based Visualization by the Air Force Wright Laboratory, Rome, NY
- OSD00-SSW03 Semantic/Context Based Data Collection, Management and Visualization by the Air Force Wright Laboratory, Rome, NY
- OSD00-SSW04 Target Tracking with a Distributed Sensor System by the Office of Naval Research
- OSD00-SSW05 Wireless Surveillance Scalable Sensor Netting by the Office of Naval Research
- OSD00-SSW06 Low Cost implementation of High Density Wireless Networks by the Office of Naval Research and the Naval Surface Warfare Center, Philadelphia Division
- OSD00-SSW07 Wireless Networks for Disaster Control and Bandwidth Augmentation by the Office of Naval Research and the Naval Surface Warfare Center, Philadelphia Division
- OSD00-SSW08 Hardware Compression of Video Data by the Army Night Vision Laboratory
- OSD00-SSW09 WeatherWeb Sub-Web Meteorological Sensor Array by the Army Research Laboratory
- OSD00-SSW10 Unmanned Aerial Vehicle (UAV) Meteorological Sensing Package by the Naval Research Laboratory

Topic Descriptions are provided on the following pages.

OSD SMART SENSOR WEB TOPICS

TOPIC NUMBER: OSD00-SSW01 TITLE: Sensor Data Collection Management Over a Web

DOD CRITICAL TECHNOLOGY: This effort supports the Defense Technology Area Plan for Sensors, Electronics and Battlespace Environment in the areas of dominant battlespace knowledge, precision force and combat ID. Specifically it satisfies, in part, the (DTAP) articulated warfighter needs for interfacing imaging and non-imaging sensors into the C4I structure for military operations in an urban environment. It enhances battlespace knowledge for the urban warfighter by providing improved situation awareness in the urban environment

MAIL ALL PROPOSALS TO
Janis Norelli
AFRL/IFB (SBIR POC)
26 Electronics Pkway.
Rome, NY 13441

OBJECTIVE: Perform an investigation of technologies to enhance mission planning, situation awareness and post-mission analysis for operations employing unattended ground sensors (UGS) and develop prototype tools which provide a systematic solution in these areas, particularly when applied to multiple systems tied together in a Web type architecture.

DESCRIPTION: Modern intelligent sensor systems provide operational challenges to the soldier who may not completely understand functionality or emplacement, for information management of the large amount of data, and for the organization and presentation of the information at multiple echelons where it may be used. A systematic plan of planning, organization, data reduction, and information presentation is required if large scale systems are ever to be effectively used in strategic or tactical situations.

The mission planning investigation would focus on geographical information system (GIS) technologies supporting hierarchical overlays representing scalable levels of mission detail from theater views down to sensor views. In addition, various map types and coordinate systems (i.e., latitude/ longitude, MGRS, etc.) will also be examined. Mission execution capabilities to be explored will include sensor transaction (i.e., message) and imagery database requirements, as well as advanced visualization and presentation tools to enhance users' situational awareness. Post-mission analysis tools will also be investigated, such as mission playback and simulation capabilities to be used for training, rehearsal, and mission analysis. The contractor will investigate tools ("templates") usable /selectable at higher and lower echelons on the Information Web to enhance and coordinate all of these activities. They will incorporate knowledge of sensor performance and logic required to accomplish a defined set of missions. They will be built as objects, which will be scalable to larger sets of templates.

PHASE I: Define structures, methods of control and interaction over the Web, and demonstrate a simple subset.

PHASE II: Prototype a software system in conjunction with the Information Integration Web.

PHASE III DUAL USE APPLICATIONS: Technology is directly applicable to Commercial surveillance and monitoring and Intelligent transportation systems.

OPERATING AND SUPPORT COST REDUCTION: Mission planning tools have the potential to reduce training and planning time and costs, and information management and presentation can reduce time and personnel required to monitor and react to any situation.

KEYWORDS: Intelligent Sensor Systems, Situation Awareness, Mission planning, information management

REFERENCES:
1. Air Force Space Command. Mission need statement. Subject: Final Mission Need Statement (MNS) AFSPC 001-94 for Wide Area Security System (WASS) ACAT Level IV, 26 May 1995.
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3. Headquarters Air Force security police. Operational requirements document. Subject: Operational Requirements Document (ORD) HQ USAF 006-93-I/II/III Priority Resource Security System (PRSS) ACAT Level III, 20 February 1996.
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5. Attended Tactical Ground Sensors: A Must For Force And Resource Protection by Michael F. Pasquin, Lt Col, USAF, A Research Report Submitted to the Faculty Maxwell Air Force Base, Alabama April 1, 1997
6. William J. Perry, Secretary of Defense. "Report to the President on the Protection of U.S. Forces Deployed Abroad," 15 September 1996, n.p. On line. Internet, 30 December 996.Available from http://www.dtic.mil/defenselink/pubs/downing_rpt/report_f.html .
7. Defense Advanced Research Projects Agency. (1998), "SAS Systems Capability Document". Arlington, Virginia 22203
8. Small Unit Operations/Situational Awareness System http://www.darpa.mil/ato/programs/suo/SUOSAS.html
9. Wireless Application Protocol Approved Specifications http://www.wapforum.org/what/technical.htm#Approved
10. Wireless Application White Papers http://www.wapforum.org/what/whitepapers.htm
11. Global Mobile Information Systems Overview http://www.darpa.mil/ato/programs/glomo/index.htm

TOPIC NUMBER: OSD-SSW02 TITLE: Protocols for Wireless Data Management

DOD CRITICAL TECHNOLOGY: This effort supports Defense Technology Objectives and the Defense Technology Area Plan in the areas of "Information Management and Display (IM&D)" and "Design Integration (DI)." It also relates to the DTAP for Sensors, Electronics and Battlespace Environment. It expands the technology capabilities of the "21st Century Land Warrior" by addressing the needs for providing and visualizing information on wireless devices to the individual soldier fighting in an urban environment and his/her chain of command.

MAIL ALL PROPOSALS TO
Janis Norelli
AFRL/IFB (SBIR POC)
26 Electronics Pkway.
Rome, NY 13441

OBJECTIVE: Develop device profile prototypes for visualization.

DESCRIPTION: The ability to quickly access and use sensor data is critical to the success of today's soldier. This is especially true for military missions in an urban environment. Advancements in sensor-based technology provide exciting new options to enhance situational awareness. To exploit these advances, the display of sensor data must be tailored to meet the requirements of the individual solider and customized for the output device used to access mission critical data.

The emergence of wireless devices, which allow users to remotely view online data, will dramatically alter the way information is delivered and used in future conflicts. These devices include portable computers, handheld devices, and enhanced cell phones. On the smallest devices, current visualization methods have focused on simple approaches, such as tables of data. There is a critical need to develop new approaches that more effectively convey real-time information. These approaches also need to be consistent with wireless bandwidth and screen size parameters. In addition, they should be logically related to visualization techniques used when screen size and bandwidth are not an issue. This will allow users to readily shift from desktop systems on a LAN to handheld wireless devices with minimal training.

PHASE I: Develop detailed profiles based on the end-user, the data content to be provided, and the device being used to display the data. These devices will include, at least, portable computers, handheld devices and enhanced cell phones. These profiles are then used to develop visualization concepts, which can dynamically generate the data within a few seconds from its original request. These concepts need to be consistent with wireless network bandwidths that exhibit intermittent connectivity.

PHASE II: Using the profiles and approaches from Phase I, develop prototype software to accept requests for and dynamically generate visual data for a portable computer, a handheld devices, and an enhanced cell phone at a minimum. A demonstration of the prototype software will be performed and metrics will be computed to characterize its performance and value.

Three primary groups of metrics will be used for system evaluation; usability, timeliness, and mission impact. Usability metrics will measure the ability of the soldier to interpret and act on the information. Timeliness metrics will help determine if the information arrives in time to support soldier tasking. Mission Impact metrics will assess the overall utility of the system.

PHASE III DUAL USE COMMERCIALIZATION: In the DoD sector this technology will provide the underpinning for wireless information distribution and use. In Command and Control settings, it will allow remote access to information in time critical situations. It is anticipated that on the battlefield of the future, handheld wireless devices will be prevalent. This approach could also be used to provide visualization of situational data to the Land Warrior heads-up helmet display. This research will provide the foundation for soldiers in the field to more effectively communicate. In the civilian sector, emergency response is an ideal application area. This technology would enable civilian responders to more effectively handle natural or weapons of mass destruction disasters, and provide the basis for coordination between local, state, and federal forces.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Wireless visualization will significantly increase situational awareness in the field and allow for more effective communications, which would allow for a reduction in personnel required to support and execute a mission.

KEYWORDS: Intelligent agents, visualization, heterogeneous data sources, data fusion, Smart Sensor Web.

REFERENCES:

1. Carnegie Mellon has been involved in multi-agent software development activities including Retsina (http://www.cmu.edu).
2. DARPA (Defense Area Research Projects Agency) is currently involved in many agent based systems development efforts. (http://www.darpa.mil/iso) (Mularie)
3. DARPA Rome Planning Initiative (ARPI)(http://www.if.afrl.af.mil/div/IFT/IFTB/arpi/arpi.html)
4. DARPA Initiative Project Genoa (http://galactic.saic.com/Projects/Genoa)
5. Center for Army Lessons Learned: Lessons on Urban Combat Operations, Newsletter 99-16
6. FM 90-10-1: "An Infantryman's Guide to Combat in Built-up Areas"
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8. Small Unit Operations/Situational Awareness System http://www.darpa.mil/ato/programs/suo/SUOSAS.html
9. Wireless Application Protocol Approved Specifications http://www.wapforum.org/what/technical.htm#Approved
10. Wireless Application White Papers http://www.wapforum.org/what/whitepapers.htm
11. Global Mobile Information Systems Overview http://www.darpa.mil/ato/programs/glomo/index.htm

TOPIC NO: OSD00-SSW03 TITLE: Semantic/Context Based Data Collection, Management and Visualization

DOD CRITICAL TECHNOLOGY: This technology supports the DTAP area of Information Management and Display (IM&D) and Design Integration (DI). It addresses the major challenge of information overload and supports the warfighter needs of maintaining real time knowledge of the battlespace environment for urban warfare. It supports the DTO objective: "21st Century Land Warrior." Agent based visualization in Smart Sensor Web would significantly expand the existing visualization capabilities by using agents to aid in presentation of critical and user-based displays.

MAIL ALL PROPOSALS TO
Janis Norelli
AFRL/IFB (SBIR POC)
26 Electronics Pkway.
Rome, NY 13441

OBJECTIVE: Develop visualization prototypes for use in data intensive, time critical applications with distributed data sources.

DESCRIPTION: Modern computing and communication advances have led to the development of system architectures with distributed nodes of data that provide large volumes of complex information. Users need a support tool that has the ability to retrieve, organize, and display information based on these complex and heterogeneous data sets. The characteristics of the data vary considerably in terms of data dimensionality and rate of change. For example, the information from one source could provide imagery or maps, with or without time varying overlays. Another source might provide simulation results containing static data points that lend themselves to Gantt chart representations.

A variety of display modalities are required to effectively represent appropriate information. Intelligent Software Agents have the potential to assist with modality selection, given a particular user and problem. These software agents may also provide more than display modality selection. For example, to assist users with navigation, links between various data types are highly desirable. A software agent could automatically generate these links. Similarly, a software agent could automatically generate overlays and alerts. Other agents could monitor user interaction and suggest alternate views or actions. Software agent technology, through the use of common ontologies can support the automatic fusion of information across multiple heterogeneous sources.

PHASE I: Identify intelligent software agents for data intensive, time critical visualization in Smart Sensor Web. Develop scenarios of use and evaluation metrics to assist in selection of specific agents for implementation. Delineate possible implementation architectures to support multiple cooperating intelligent software agents. Develop evaluation metrics to assist in selection of an implementation architecture.

The key areas of research interest for the application of software agents to visualization are: 1. Semantic and ontological database representation for fusion; 2. Visualization techniques; 3. Data fusion; 4. Interconnection infrastructure requirements; 5. Multimedia interfaces; 6. User interface prototype; 7. development; 8. Develop metrics to characterize system performance.

The representative metrics and technical performance parameters to be considered include: a. Latency and response time; b. Data search completeness; c. Data search efficiency; d. Success rate for displaying information in appropriate and optimal formats; e. Number and type of display formats.

Representative real data sources include: map data (GIS), map overlays, intelligence data, key resource and status data, and weather data.

PHASE II: Develop and demonstrate prototype tools to include semantic based access to multiple data sources, data fusion, and the display of information in appropriate user-defined formats. Test the prototype tool against metrics defined in Phase I to characterize system performance and value.

PHASE III DUAL USE COMMERCIALIZATION: This technology development is applicable in any environment with large volumes of diverse data where users are required to make rapid decisions. This is a typical challenge faced in the command & control area. There are many DoD and civilian instances where the commercialization of this capability would significantly impact the quality and timeliness of decisions.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Intelligent software agents have a potential to reduce operating time and costs by reducing the "Man-in-the-Loop" time that would be required to identify data sources and subsequently sort through data to identify relevant data for his/her operation. They can act as the "silver bullet" to provide only that information that is required to accomplish a specific mission without information overload or operator human interface complexities. They can act in a timely manner only when required to act.

KEYWORDS: Intelligent agents, visualization, heterogeneous data sources, data fusion, Smart Sensor Web.

REFERENCES:
1. DARPA (Defense Area Research Projects Agency) is currently involved in many agent based systems development efforts. (http://www.darpa.mil/iso) (Mularie)
2. DARPA Rome Planning Initiative (ARPI)(http://www.if.afrl.af.mil/div/IFT/IFTB/arpi/arpi.html)
3. DARPA Initiative Project Genoa (http://galactic.saic.com/Projects/Genoa)
4. Center for Army Lessons Learned: Lessons on Urban Combat Operations, News letter N0.99-16
5. FM 90-10-1: "An Infantryman's Guide to Combat in Built-up Areas"

TOPIC NUMBER: OSD-SSW04 TITLE: Target Tracking with a Distributed Sensor System

DOD CRITICAL TECHNOLOGY: Sensors; Computing and Software Technology

MAIL ALL PROPOSALS TO

Mr. John Williams
Deputy Program Manager, Navy SBIR Program
Office of Naval Research (Code 364)
800 N. Quincy St
Arlington, VA 22217-5660

OBJECTIVE: Develop methods for continuous detection, tracking, classification and geolocation of moving objects with a distributed system of imaging and non-imaging sensors.

DESCRIPTION: Coordinated imaging (e.g., panchromatic, color, low-light and thermal infrared) and non-imaging (e.g., acoustic, seismic, magnetic) microsensors, each with organic real-time processing capabilities, linked in a distributed system hold promise for continuous situational awareness operating in all-weather terrestrial environments. At the local sensor/processor level, technical challenges include adaptive characterization of the ambient environment, detection, tracking, classification and geolocation of vehicles, humans and animals with high probability of detection and low rates of false alarm. At the system level, challenges include the control of potentially large numbers of heterogeneous microsensors and fusion of disparate reports into an integrated situational model that is spatially and temporally consistent. Further, the distributed system needs to provide multiple users with tailored viewpoints into the real-time situational model with access to individual sensor reports as well as supporting retrospective analysis.

PHASE I: Refine concepts for integration of identified smart sensor components and algorithms to meet system objectives within the framework of specific targeted commercial and military applications. Identify critical design issues, specify targeted commercial system and appropriate APIs, and conduct experiments to establish feasibility. Develop means to quantify and evaluate system performance. Deliver a specification, development plan, testing plan and cost estimate for the prototype system.

PHASE II: Develop prototype hardware and software to demonstrate and test system performance in accordance with testing plan. Evaluate operating characteristics of the implemented system. Prepare marketing plan for targeted commercial and military applications.

PHASE III DUAL-USE COMMERCIALIZATION: Potential dual use applications lie in both defense and civilian applications for security surveillance and monitoring. Military applications include smart sensor networks for tactical as well as fixed facility force protection and security. Commercial applications include sensor networks for facility, perimeter and border security.

REFERENCES: Lukes, G. E. (Editor), *Proceedings of the 1998 Image Understanding Workshop*, Morgan Kaufmann Publishers, San Francisco, California, ISBN 1-55860-583-5 (1998). Note Section 1 -- Video Surveillance and Monitoring (VSAM); also see VSAM Home Page at http://www.cs.cmu.edu/~vsam/vsamhome.html.

KEYWORDS: Sensors; image understanding; computer vision; real-time image processing; video surveillance and monitoring; motion detection; object tracking; Smart SensorWeb.

TOPIC NUMBER OSD00-SSW05 TITLE: Wireless Surveillance Scalable Sensor Netting

DOD CRITICAL KEY TECHNOLOGY: Smart sensor netting and information technology

MAIL ALL PROPOSALS TO
Mr. John Williams
Deputy Program Manager, Navy SBIR Program
Office of Naval Research (Code 364)
800 N. Quincy St
Arlington, VA 22217-5660

OBJECTIVE: Develop a low cost semi intelligent microprocessor controlled network of sensors and change-delta-communications platforms that can be used by service members to provide rapid and accurate data fusion for own position and targeting of enemies or enemy positions. This technology will greatly enhance situational awareness in a Military Operation Urban Terrain (MOUT) environment.

DESCRIPTION: One of the big challenges in MOUT is establishing reliable and accurate contact reports. Many times this information is slow and inaccurate or incomplete, potentially resulting in the use of the wrong weapon for the situation. The purpose of this effort is to develop a networked system capable of providing rapid and accurate information via wireless communication for use in targeting and intelligence as well as providing own position data. This system will be integrated into a high bandwidth wireless network which will provide the change of information directly to a peer sensor for accuracy improvement and then to the appropriate receiver. The system will in effect provide imagery and other data "directly after peer review" into the Sensor-to-Shooter wide band network. Though the Sensor-to-Shooter network is wide band, the data throughput in the network of sensors developed in this effort will be limited (≤ 16 kbps) due to such factors as platform size limitations and interference from other platforms and buildings. This data will include sensor/soldier position data as the sensor and/or soldier navigates. This terrain may comprise enclosed structures as well as open terrain. Therefore establishing and communicating position and targeting data must take such terrain into consideration. Semi-intelligent microprocessor technology will enable the network to be controlled by a lead sensor platform with overall control established by the soldier. The system may make use of more than one method (GPS, RF tag reader…) to derive accurate position information. A system of multiple sensors with peer to peer or client-server communication, depending on system employment, will establish precise targeting information. The system should be capable of wireless communication between the sensors and with soldiers. Individual platform size and weight should be small enough that a dismounted soldier can easily carry the device to the employment area. The key to a successful effort is to 1). minimize N^2 STAR topology communication necessity with explosive bandwidth requirements as N increases, 2). maximize performance by providing sensor pre-processing fusion, and 3). integrate the common battle-space picture into a Joint Image Web thus providing a highly capable integrated system greater than the sum of its parts.

PHASE I: Provide detailed analysis of battlefield requirements for targeting and positioning data. Identify and assess the feasibility for an appropriate system solution to meet the requirements of a low-cost device capable of providing targeting and positioning data via wireless communication in MOUT.

PHASE II: Develop and demonstrate a prototype autonomous or semi-autonomous mobile device capable of transmitting image and position data to a peer device and remote location.

PHASE III DUAL USE APPLICATIONS: Building on Cooperative Engagement Capability (CEC) technology, integrate a fully networked system of sensor platforms into the high bandwidth Sensor-to-Shooter network. In addition to providing real time targeting and position data in a Joint Image Web environment, this system will provide accurate information for police and fire fighting rescue operations. The ability to capture imagery from a mobile platform has application as a security system where stationary platforms are undesirable.

REFERENCES:

1. Military Operations On Urbanized Terrain - Instrumentation System (MOUT-IS) Evaluation Report, Naval Air Warfare Center Training System Division Technical Report 98-016, November 1998
2. W. Rankl and W. Effing, Smart Card Handbook, John Wiley & Sons, 1997
3. Wavelet Application, Journal of Electronic Imaging, October 1998.
4. SSW OSD Web Page

TOPIC NUMBER: OSD00-SSW06   TITLE: Low Cost implementation of High Density Wireless Networks

SCIENCE/TECHNOLOGY AREA: Electronics / Sensors, Computing and Software

MAIL ALL PROPOSALS TO
Mr. John Williams
Deputy Program Manager, Navy SBIR Program
Office of Naval Research (Code 364)
800 N. Quincy St
Arlington, VA 22217-5660

OBJECTIVE: Develop a low Probability of destructive interference spread spectrum encoding scheme and transceiver that can port a multitude of users in confined area (ship compartment) and be implemented at low cost.

DESCRIPTION: Wireless communications for data voice, and command and control offers unprecedented system design advantages such as installation flexibility, weight reduction, improved data quality, and data acquisition from previously inaccessible locations. Wireless systems are quickly finding their way into a wide variety of applications including commercial business and high technology military.   Most of the new short range wireless systems use some form of *Spread Spectrum* modulation.   This technique minimizes frequency conflicts with narrow band systems but presents considerable interference to another spread spectrum system operating within the, same frequency space. The commercial demand for spread spectrum has stimulated market growth to an alarming degree. As the number of fielded systems increase, the potential for a inter-system interference increases. A need exists to devise modulation techniques that (1) use available spectrum as efficiently as possible and (2) present die lowest possible conflict levels to other systems in the same space. CDMA (Code Division Multiple Access) processes can encode broadcast date in ways that provide the optimum use of available bandwidth with the lowest possible probability of destructive collisions. This topic suggests the exploitation of spread spectrum modulation techniques with the encoding diversity of CDMA theory in order to maximize the efficiency of spectrum use and to provide minimum probability of destructive interference with other spread spectrum emitters as well as narrow band system emitters.

PHASE I: Investigate the use of COTS hardware with CDMA coding techniques and define a system tat would demonstrate basic CDMA operation using commercial hardware.

PHASE II: Design, prototype, and test a short range CDMA (or alternative, encoding scheme) system that can be tested to verify interference performance with narrow band systems ads wall as spread spectrum systems.

PHASE III. Develop a production CDMA network suitable for commercial and military implementation and prepare for commercialization.

COMMERCIAL POTENTIAL CBM is an emerging market with tremendous potential in the US Navy, petro-chemical, pulp and paper, construction equipment, aerospace and consumer appliance markets, Wireless installation addresses the primary cost factor limiting implementation of high performance health monitoring systems. As the use of the RF spectrum increases, schemes that make more efficient use of the available spectrum will gain commercial advantage and realize the burgeoning market for CBM systems.

REFERENCES.- Nickerson, 0. W. B Thomason, "Hierarchical Open Architecture Approach to Shipboard Condition-Based Maintenance," ASNE Condition Based Maintenance Symposium, June 1998

Key Words: Condition-Based Maintenance, CBM, Wireless, CDMA, RF

TOPIC NUMBER OSD00-SSW07 TITLE: Wireless Networks for Disaster Control and Bandwidth Augmentation

SCIENCE/TECHNOLOGY AREA: Networking, Computing and Software

MAIL ALL PROPOSALS TO
Mr. John Williams
Deputy Program Manager, Navy SBIR Program
Office of Naval Research (Code 364)
800 N. Quincy St
Arlington, VA 22217-5660

OBJECTIVE: Develop a wireless intra-ship communications network architecture, which will provide ultra-reliable high-speed transport during battle conditions and provide bandwidth augmentation services for special applications.

DESCRIPTION: It is essential, during combat and emergency situations, that the commanding officer have as much real-time information that is available. Accurate battle damage assessment is crucial to the ship's survivability. The flow of information is dependent on the network connectivity during this chaotic time.

Time sensitive information not delivered on time is of no value. The wireless network must show reliability, accessibility, and resilience in a ships normal topology and in a plastic combat scenario. The RF wireless must establish and maintain propagation in harsh and tortuous conditions. The EM boundary conditions are not known, or currently well understood. Reconstitution of the network or sub-nets must be done quickly and without human intervention during a changing topology. Auto routing during battle conditions must be done with efficient allocation of bandwidth and prioritization of information. The wireless network must provide a suite of connectivity services to support existing and next generation machinery and automation applications, conditioned-based maintenance and high-voltage and current power electronics. The network shall be capable of co-existing with and interfacing with other wireless devices including but not limited low and high-power devices within the frequency range of 60 Hz to 10 GHz.

The network shall be scalable in terms of component size, power, bandwidth and reusability. The network shall include embedded diagnostics and supervision Agent that provides a god's eye view of utilization, link integrity, and fault projection and suggestive remedies.

The network shall be compatible with all current and next generation IP protocols.

PHASE I: Obtain background information. Scope the problem. Investigate the use of COTS hardware and define a system that would demonstrate operation using commercial hardware. Establish the EM boundary conditions with the goal of creating an installation and verification software application that can be used for audit and verification purposes.

PHASE II: Design, prototype, and demonstrate a prototype ship network system that can be tested to verify interference performance with existing narrow band systems as well as spread spectrum systems.

PHASE III: Develop a production ship network suitable for commercial and military implementation and prepare for commercialization.

COMMERCIAL POTENTIAL: Wireless networking is an emerging market with tremendous potential in the US Navy, petro-chemical, pulp and paper, construction equipment, aerospace and consumer appliance markets, Wireless installation addresses the primary cost factor limiting implementation of high performance networking. As the use of RF spectrum increases, schemes that make more efficient use of the available spectrum will gain commercial advantage and realize the burgeoning market for Wireless networking.

REFERENCES

1. Nickerson, 0. W. B Thomason, "Hierarchical Open Architecture Approach to Shipboard Condition-Based Maintenance," ASNE Condition Based Maintenance Symposium, June 1998,
2. William M. Brown, "Industrial wireless communications grabs the latest technologies" RF design, January 2000

KEY WORDS: Condition-Based Maintenance, Wireless, RF, networks.

TOPIC NO: OSD00-SSW08 TITLE: Hardware Compression of Video Data

DOD CRITICAL TECHNOLOGY: Information Systems & Technology (Information Processing)

MAIL ALL PROPOSALS TO
NVESD
ATTN: AMSEL-RD-NV-OPS-TPP (Linda Kline)
10221 Burbeck Rd Ste 430
Ft. Belvoir VA 22060-5806

OBJECTIVE: Develop a hardware based image compression to move video streams for real time viewing and interaction of both live and simulated images. Micro-second latencies and a 10:1 compression ratio are desired.

DESCRIPTION: There are a number of sources of military video imagery that support product development, training, battlefield operations and situational awareness. There will be many more such sources with the proliferation of small and low cost sensors on the battlefield. Realistic simulated video images from all regions of the electromagnetic spectrum support virtual experiments and exercises to reduce the cost of development of sensors and sensor systems, assist in battle planning and rehearsal, assist in evaluating the worth of the information sensors provide, and provide for interactive training simulators.. To produce realistic simulations of full motion video requires larger capacity computing resources than are not normally available. Distributed simulation allows for centralized computation, however the video stream must reach the experiment site with minimal latency and sufficient resolution for identification of entities and sufficient frame rate to determine in what actions the entities are engaged.

The future battlefield will utilize far more sensors than in the past and the information from those sensors will be available more universally. Particularly for the Smart Sensor Web program, locally generated sensor/imager data will be available to the local units. Transmitting such image data real time, either locally or to a central distribution point, requires significant bandwidth. Lossless hardware compression would provide a robust means of delivering such data.

PHASE I: Analyze alternative compression approaches to compress real time data in a synchronous ATM environment. Develop and demonstrate feasibility of compression algorithm implementation on hardware so as to minimize latency for real time interactive video on demand. Proof of principle results will be incorporated in reports and presentations.

PHASE II: Develop a prototype and demonstrate compression of four 640 x 480 x 8 bits video streams at 30 Hertz over an existing ATM based, OC-3 link (155 megabits/second). At least 4:1 compression ratio is required, 10:1 is desired with minimal loss.

PHASE III DUAL USE COMMERCIAL APPLICATION: This technology has broad commercial applicability for both military and civilian applications. Military applications include integration of a proof of principle prototype into US Army Paint the Night distributed simulator, sensor networking, battlefield command and control, battlefield situational awareness and realistic/interactive training. Civilian applications include personal communications, distance learning, and internet gaming markets, which use synchronous delivery of streaming video over wide area networks.

OPERATING AND SUPPORT COST REDUCTION: Data compression can allow significant improvement of data transmission over a battlefield network, improving the decision making capability of the warfighter in an information-centric battlefield. Data compression also has the potential to reduce program simulation costs by sharing high cost image generators across multiple users in distributed simulations. Significant cost reductions and enhancements can be realized for distributed training simulators.

KEYWORDS: Compression algorithms, MPEG3, Lossy/lossless compression, virtual reality, wide area networks, ATM.
REFERENCES:
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TOPIC NUMBER: OSD00-SSW09 TITLE: WeatherWeb Sub-Web Meteorological Sensor Array

DoD CRITICAL TECHNOLOGY: Sensors

MAIL ALL PROPOSALS TO
Ms. Linda Duchow
US Army Research Laboratory
AMSRL-IS-E
WSMR, NM 88002-5501

OBJECTIVE: Develop a prototype WeatherWeb meteorological sensor sub-web array.

DESCRIPTION: The future battlefield will demand environmental information in vastly greater quantities than current tactical weather systems can supply. Much of this information will result from inference of weather data from other sensor outputs. Future Tactical Decision Aid products will require that a critical portion of the weather information come directly from meteorological sensors emplaced in key locations throughout the battle domain. A local sub-web of miniature low-power, expendable meteorological sensors, remotely placed with wireless communication to send data to a central node, will be the basis of that battlefield sensor web capability. The sub-web sensors will provide direct or indirect environmental data from among the parameters of temperature, winds, pressure, humidity, visibility, precipitation and weather-impacted terrain conditions. The central node will possess the ability to make remote measurements vertically of winds and possibly temperature/humidity, and will locally pre-process the resultant sub-web data to perform quality control, and minimize subsequent communications bandwidth. The final system will integrate with the other Smart SensorWebs, Imaging, Weapons, Integration and Simulation, to provide unprecedented battlefield situational awareness.

PHASE I: Design a miniature remote sensor package, for surface measurement of temperature (air and soil), pressure, humidity, visibility, soil moisture and winds with power, location, orientation, and communications. Design a central node processor/sensor, with vertical sounding of winds from 10 m to at least 300 m above the platform, in addition to the sensors from the remote units. Also include the required power, location, orientation, and communications, with the ability to transmit the cumulative data to a remote collection point that may be up to 6-10 km distant. The central node also will be able to receive polling instructions from the collection point and poll the remote sensors. These designs will define the miniature sensor package and the central node sensor package, and will include blueprints and other drawings, schematics, and descriptions necessary for construction of a prototype under Phase II.

PHASE II: Developed prototype hardware and software to demonstrate the ability to sense, collect and transmit the meteorological sensor data to an external remote collection site. Demonstrate this sub-web.

PHASE III DUAL-USE COMMERCIALIZATION: The OSD anticipates that this capability, incorporated into a comprehensive meteorological support system, would provide critical environmental information in support of National Forest Service fire fighting, in the National Parks for environmental monitoring, and would become part of the US Army and US Marine field sensors associated with their tactical meteorological support systems. Use by FEMA for disaster support could also be anticipated. Commercial activities, that require environmental monitoring of possible toxic manufacturing processes, would also employ both hard-powered and battery-powered versions of this system. Integrate and demonstrate the sub-web as part of the Smart SensorWeb experiment program at the Ft. Benning MOUT site, as well as test at the WeatherWeb Testbed in western Massachusetts.

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KEYWORDS: sensors, meteorological, miniaturization, and wireless communications.

TOPIC NUMBER: OSD00-SSW10 TITLE: Unmanned Aerial Vehicle (UAV) Micro-Meteorological Sensing Package Development and Application

DoD CRITICAL TECHNOLOGY: Sensors

MAIL ALL PROPOSALS TO
Dr. Ted Tsui, Code 7540
Naval Research Laboratory
7 Grace Hopper Ave.
Monterey, CA 93943-5502

and

John Adams, Code 3230 (Contracts)
Naval Research Laboratory
4555 Overlook Ave. S.W.
Washington DC 20375-5320

OBJECTIVE: Develop a micro-meteorological sensing package for operational deployment in Unmanned Aerial Vehicles (UAV) to explore, demonstrate, and evaluate meteorological data collection in the battlespace environment.

DESCRIPTION: Future battlefields will supply environmental information in vastly greater quantities than currently possible. Most of this information will involve inference of weather data from other sensor outputs. Future Tactical Decision Aid products will require that meteorological sensors emplaced in key locations throughout the battle domain sense a critical portion of the weather information. One of the most important areas of sensing is in the atmosphere immediately above the battlefield, in the surface and planetary boundary layer, and to higher altitudes as well (0-5 km vertical height). The use of a micro-meteorological sensing package in UAV's that provide position, altitude, pressure, temperature, humidity, wind, and possibly visibility, the presence of cloud, ice, and turbulence detection, has great value to what is otherwise a data sparse region. The effort proposed would be to identify sensors that can reasonably be expected to be productive in a battlespace environment, and that can be mounted on a UAV.

PHASE I: Design a miniature remote sensor package, appropriate for use on UAVs to collect observations of position, altitude, pressure, temperature, humidity, wind, and possibly visibility, the presence of cloud, ice, and turbulence detection. Conduct simulation and impact analysis of the sensor package mounted in a UAV. In addition, the effort shall include a strategy for communication links, data flow and data ingest into several battlespace analysis systems, including nowcast and existing numerical weather forecast capabilities. The USD is particularly interested in determining the specific value gained by fielding such a capability, to examine the benefits in a quantitative manner. Three specific vertical domains are of interest: the surface boundary layer (below 1 km), the planetary boundary layer (1-3 km), and mid troposphere (3-5 km). A proposed means of validation of the value of the sensor package is to be provided in Phase I.

PHASE II: Develop the prototype sensor package. Test and evaluate its application in a simulated UAV. Demonstrate the in-flight data collection and communication capability as part of the Smart Sensor Web at the WeatherWeb Testbed in western Massachusetts. Collaborate with service weather web components to conduct simulated operational field experiments to determine value added to nowcast and forecast capabilities within the battlespace environment. The ability to verify the "test" cases from real-time and post analysis cases will be an important element of the work.

PHASE III DUAL-USE COMMERCIALIZATION: Conduct demonstration of the UAV sensor package technology with civilian usage. The OSD anticipates that this capability, incorporated into a comprehensive meteorological support system, would provide critical environmental information in support of air pollution monitoring in major metropolitan areas. National Forest Service fire fighting activities frequently are hampered by lack of environmental information, due to the remoteness of the regions involved. This dual use of the technology requested here is but two of the possible benefits that could be derived from a successful simulation and demonstration.

REFERENCES:

1. Mesoscale numerical weather prediction description: Hodur, R., 1997: The Naval Research Laboratory Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS). *Monthly Weather Review* 125, 1414-1430.
2. Tactical Atmospheric Modeling System – Real Time project description: http://stratus.nrlmry.navy.mil/
3. NOWCAST project description: Anonymous ftp://ftp.nrlmry.navy.mil/pub/receive/tsui

KEYWORDS: meteorological sensors, miniaturization, nowcasting, forecasting, and data assimilation

OSD DEPUTY UNDER SECRETARY of DEFENSE(S&T) / DEFENSE HEALTH PROGRAM BIOMEDICAL TECHNOLOGY FOCUS AREA

The Jointly Sponsored Deputy Under Secretary of Defense (S&T) and Defense Health Program Office have established this focus area to explore biomedical technology research issues. The biomedical technology area is focused to yield essential technology in support of the DoD mission to provide health support and services to U.S. Armed Forces. Most national and international medical S&T investment is focused on public health problems of the general population. Military medical S&T is concerned with developing technologies in order to preserve combatants' health and optimal mission capabilities despite extraordinary battle and non-battle threats to their well being. Preservation of individual health and well being sustains warfighting capabilities. The Biomedical Reliance Panel is included within the overarching structure of the Armed Services Biomedical Research Evaluation and Management (ASBREM) Committee, which provides joint coordination and cooperation to ensure synergy across all biomedical programs.

We have chosen the following topics and Service Laboratory Executive Agents to manage the SBIR topics in this technology area:

- OSD00-HP01 Three-Dimensional Model of Thermoregulation by the Naval Health Research Center Detachment at Brooks Air Force Base, TX
- OSD00-HP02 Enhancing Malaria Vaccine Development by the Naval Medical Research Center
- OSD00-HO03 Functional Genomic Analysis of the Malaria Parasite by the Naval Medical Research Center
- OSD00-HP04 Systems For Improved Red Blood Cell Storage by the US Army Medical Research Acquisition Activity
- OSD00-HP05 Blast Mitigation Jacket for Training by the US Army Medical Research Acquisition Activity
- OSD00-HP06 Analysis and Interpretation of Real-Time Multi-Parameter Biological Data by the US Army Medical Research Acquisition Activity

Descriptions of the biomedical topics are on the following pages.

Navy Medical Research Topics

TOPIC NUMBER: OSD00-HP01 TITLE: Three-Dimensional Model of Thermoregulation

DOD CRITICAL TECHNOLOGY: Biomedical - Military Operational Medicine

MAIL ALL PROPOSALS TO
Officer in Charge
Naval Health Research Center Detachment Brooks AFB
Attn: John Ziriax
8301 Navy Road
Brooks AFB, TX 78235-5365

OBJECTIVE: Develop a 3-D Computational Model of Thermoregulation

DESCRIPTION: Optimal mental and physical performance requires an optimal thermal environment. Wherever maximum performance is critical or the environment is hazardous, the importance for maintaining the human body's temperature and comfort has been recognized. While most garments provide passive insulation and protection, future garments include active heating and cooling mechanisms as well as complex control sensors. These will give the wearer a physical and mental "edge" over those less well protected. The design and development these garments could proceed by the repeated construction and testing of expensive prototypes or, as has been done with many development efforts, a computer model could be used to speed this process and save money. This topic solicits the development of an anatomically realistic model of human thermoregulation. The model would be used to analyze sources of thermal stress such as ambient temperature, wind chill, protective garments, and directed energy weapons, which may occur alone or in combination. It would aid in risk assessment, the development of specialized garments and protective equipment, the design of working environments, personnel training procedures, and in understanding thermoregulation in general. The area of thermal modeling especially as applied to biological systems has a wide number of potential applications, but has been slow to develop because of the complexity of anatomical data sets. The development of realistic anatomical sets by military laboratories should overcome this problem. The current state of anatomically realistic thermal modeling has yet to incorporate passive physical mechanisms. This model will be a useful produce by itself, and it would also serve as the starting point for a future version, which would include active physiological processes such as blood flow, vasodilatation and constriction. The model would be a significant advance in thermal modeling (3) and would be an important tool for designing and analyzing work environments, garments, and protective equipment. In addition, there are also potential medical applications where hyperthermia and hypothermia are treated or used therapeutically.

PHASE I: Using known thermal properties of different tissues and materials, develop a 3-D voxel-base model of conduction using existing digital anatomical data sets provided by the Navy (1,2). The model output should be experimentally verified. The feasibility of developing an accurate model will be demonstrated by validation of model predictions with empirical measurements of internal heat transfer in homogeneous phantoms and animal carcasses.

PHASE II: The model will be expanded to add other mechanisms of heat transfer, including convection, evaporation and environmental conditions. The final model should be parallelized using standard message passing libraries. An emphasis in software development should be on portability and scalability. At the end of this phase the prototype model should be empirically verified by measuring heat transfer internally and at the surface in phantoms and animal carcasses this time including a variety of environmental conditions and thermal sources.

PHASE III DUAL-USE COMMERCIALIZATION: The final product of this SBIR would be a realistic three-dimensional voxel-based model, which would include passive mechanisms of heat transfer such as conduction, convection, and evaporative heat loss, taking into account different environmental conditions such as ambient temperature, humidity, air flow and energy absorbed from electromagnetic force fields and other sources. A variety of external thermal sources could be modeled such as diathermy, therapeutic hyperthermia, microwave exposure, extreme cold, and wind chill. The model would analyze the effectiveness of different materials in clothing and protective equipment such as might be required in severe weather, occupational or military environments, medical treatments, or athletic activities. This model would be an enormous improvement to the current alternatives. In addition, applications of this model need not be limited to living tissues, any materials for which a temperature control system is required, could potentially be modeled and the effectiveness of the delivery system and any insulation could be assessed without the necessity of building a working system.

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1. Mason, P.A., T.J. Walters, J.W. Fanton, D.N. Erwin, J.H. Gao, J.W. Roby, J.L. Kane, K.A.Lott, L.E. Lott, and R.V. Blystone. Database created from magnetic resonance images of a Sprague-Dawley rat, Rhesus monkey and Pigmy goat. FASEB Journal, 9: 434-440, 1995.
2. Mason, P.A., J.M. Ziriax, W.D. Hurt, and J.A. D'Andrea. 3-dimensional models for EMF dosimetry. In: Electricity and Magnetism in Biology and Medicine, F. Bersani, editor, Plenum Press, 1998.
3. Fiala, Dusan, Kevin J. Lomas, and Martin Stohrer. A computer model of human thermoregulation for a wide range of environmental conditions: the passive system. J. Appl. Physiol. 87(5): 1957–1972, 1999
4. Web: http://www.brooks.af.mil/NHRC/nhrc.htm
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KEYWORDS: thermoregulation, heat transfer, thermal modeling, 3-dimensional modeling

TOPIC NUMBER: OSD00-HP-02 TITLE: Enhancing Malaria Vaccine Development

DoD Critical Technology: Infectious Diseases of Military Importance - Vaccines

MAIL ALL PROPOSALS TO
Stephen L. Hoffman, CAPT MC USNR
Address: Malaria Department
Naval Medical Research Center
503 Robert Grant Avenue
Silver Spring, MD 20910-7500

OBJECTIVE: Develop methods and produce immunogens to enhance malaria vaccine development.

DESCRIPTION: A major priority of Department of Defense biomedical research is to develop effective vaccines for preventing *Plasmodium falciparum* and *P. vivax* malaria. As compared to developing vaccines against viruses and bacteria, developing malaria vaccines is complicated by the complexity of the parasite (multiple stage life cycle, numbers of proteins, and variability) and the complexity of the human host's response to the infection. Developing sustainably effective vaccines may require immunizing with an unprecedented number of parasite-derived proteins and/or the B and T cell epitopes from these proteins, using multiple vaccine delivery systems depending upon which arms of the immune system are to be activated. This topic requests development of efficient methods for producing immunogens either as full or partial length proteins or as polyepitopes/minigenes by recombinant viruses, as purified recombinant proteins, and/or as DNA plasmids, and enhancing their immunogenicity.

Malaria vaccine development has focused on developing subunit vaccines that duplicate the protective immunity found in volunteers immunized with radiation attenuated sporozoites, or who survive until the teenage years in malaria endemic areas [1,2]. The protective immunity elicited in these models is presumably against the entire parasite, which has approximately 6,000 protein encoding genes. Current malaria vaccine development efforts are focused on two approaches. The first is eliciting excellent immune responses against a few key surface proteins by immunizing with recombinant proteins in adjuvant. One of these vaccines, RTS,S consistently provides approximately 50% protection for 1-2 months [3], a level of protection which is an excellent foundation, but must be further improved. The second approach aims at making good immune responses against most of the well characterized candidate vaccine antigens (approximately 15), and is a DNA-based vaccine approach [4]. Clinical trials of this approach are now beginning. Recognizing that the excellent immunity in the human model systems may be against 100s or 1000s of parasite proteins, work is in progress to sequence the genome of *P. falciparum* [5], the major cause of malaria mortality worldwide. Current methods of developing vaccines are probably not adequate to take advantage of these new sequence data and use it to develop vaccines [6]. Work done under this topic should aim at developing and validating methodologies, such as minigene approaches to vaccine development, that will allow for reducing the amount of parasite-derived immunogens to the minimum, while duplicating the excellent protective immunity engendered by immunization with radiation attenuated sporozoites, or by lifelong exposure to natural infection.

PHASE I: Develop prototype vaccines based on *P. falciparum* and/or *P. vivax* sequences and/or delivery systems for enhancing immunogenicity, and demonstrate in vitro expression of the proteins, antigenicity in vitro, and immunogenicity in mice.

PHASE II: Produce and purify vaccines and enhancing systems under Good Laboratory Practices (GLP) conditions, fully characterize the immunogens, and demonstrate immunogenicity and in some cases protective efficacy in non-human primates. Finalize prototype that can be transitioned to clinical testing in Phase III and eventual commercialization. Develop and demonstrate plans for transitioning to Good Manufacturing Practices (GMP) production, conducting pre-clinical safety studies, and submitting investigational new drug applications (IND) to the FDA.

PHASE III: Manufacture under Good Manufacturing Conditions (GMP) conditions, conduct pre-clinical safety and immunogenicity studies in support of investigational new drug (IND) applications to the Food and Drug Administration (FDA), prepare IND, submit IND, conduct Phase I/II safety, immunogenicity, and protective efficacy studies in human volunteers, and perform regulatory oversight of such studies. A successful malaria vaccine will eliminate the need for chemoprophylaxis in deployed troops and will prevent the degradation of fighting capabilities due to malaria infection. In addition, such a vaccine would protect civilian travelers and residents of malaria endemic areas. It is anticipated that the vaccine technologies developed will be applicable to a variety of traditional and emerging infectious diseases.

REFERENCE LIST

1) Hoffman SL. Malaria vaccine development: a multi-immune response approach. Washington, D.C.: American Society for Microbiology, 1996.
2) Miller LH, Hoffman SL. Research toward vaccines against malaria. Nat.Med. 1998; 4:520-524.
3) Stoute JA, Slaoui M, Heppner DG, Momin P, Kester KE, Desmons P, et al. A preliminary evaluation of a recombinant circumsporozoite protein vaccine against Plasmodium falciparum malaria. N.Engl.J.Med. 1997; 336:86-91.
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5) Gardner MJ, Tettelin H, Carucci DJ, Cummings LM, Aravind L, Koonin EV, et al. Chromosome 2 sequence of the human malaria parasite *Plasmodium falciparum*. Science 1998; 282:1126-1132.
6) Hoffman SL, Rogers WO, Carucci DJ, Venter JC. From genomics to vaccines: Malaria as a model system. Nat.Med. 1998; 4:1351-1353.

KEYWORDS: Vaccines, Biotechnology, Malaria, Infectious Diseases, Immunology, Force Protection

TOPIC NUMBER: OSD00-HP03 TITLE: Functional Genomic Analysis of the Malaria Parasite

DoD Critical Technology: Infectious Diseases of Military Importance

MAIL ALL PROPOSALS TO

Commanding Officer, Naval Medical Research Center
Attn: CDR D.J. Carucci
503 Robert Grant Avenue
Silver Spring, MD 20910-7500

OBJECTIVE: Develop strategies and technologies using data derived from the Malaria Genome Sequencing Project to develop anti-malarial vaccines, drugs and diagnostics.

DESCRIPTION: Malaria is caused by a complex, multistage parasite that represents the Department of Defense's most important infectious disease threat. The parasite lives in both mosquito and human hosts, much of the time inaccessible to study. It possesses a large, highly AT rich, 30-megabase genome distributed on 14 chromosomes. To date there is no licensed malaria vaccine and the parasite is developing resistance against most, if not all, current anti-malarial drugs. In addition, methods to diagnose malaria are not optimal. Efforts to identify new targets of vaccines and drugs as well as to better understand the parasite biology have recently turned to genomic sequence data derived from the Malaria Genome Project. To date, 2 of the 14 chromosomes (1) have been completely sequenced and it is anticipated that the entire genome will be complete by 2002. These data are likely to contain the foundation for future malaria vaccines, drugs and diagnostics. However, despite the sequencing of more than 15 pathogen genomes during the last 5 years, and the imminent completion of sequencing of the human genome, and the great promise of genomics for solving biomedical problems, it is not yet apparent what strategies and technologies will actually turn this vast amount of genomic sequence data into the drugs, vaccines, and diagnostics so desperately needed. One strategy has been suggested but not validated (2). Recently a focused, non-global approach has yielded potentially important vaccine target antigens for Neisseria meningitidis type B suggesting a potential for such technologies (3). Further, an important consideration is the relative low abundance of key stages of malaria parasites in human tissues, and the lack of culture systems for some pathogens of military importance, which has been problematic for the identification of protein and gene expression, required for the development of effective interventions.

In the case of the Department of Defense emerging and re-emerging infectious diseases and biological warfare threats represent serious potential threats that do not have obvious solutions. During the past 100 years when U.S. forces have been deployed to malarious areas of the world, they have always had more casualties to malaria than to hostile fire, and with the advent of multi-drug resistant malaria this threat has in many areas increased. Because of the complexity of the parasite that causes malaria and its life cycle, and the importance to the DoD of the disease caused by this parasite, malaria represents an important area for research to the DoD. This topic seeks the development and validation of novel high throughput strategies and technologies for utilizing genomic sequence data to development new vaccines and drugs for malaria. It is anticipated that these strategies and technologies will lead to the development of products for preventing malaria, and generic products for establishing stage specific gene and protein expression of free living organisms. These methodologies will be universally applicable to other pathogens, including biological warfare threats, for which effective interventions are not currently available.

PHASE I: Determination of the stage of gene and protein expression and the subcellular localization of protein expression will be critical for selecting potential targets of novel vaccines, drugs and diagnostics. Specifically, these determinations using high-throughput methodologies are likely to provide a subset of targets from the entire genome to transition to further development. A mechanism for the determination of gene and protein expression using genomic data from 25% of the completed genome needs to be developed. Validation of the expression data needs to be made.

PHASE II: The complete characterization of all gene and protein expression from multiple stages of the parasite life cycle, including sporozoite, liver stage and blood stages need to be determined. These methods should include the means to determine gene and protein expression of low abundance parasite stages, particularly liver stages. Validation of these characterizations will be essential. This phase of the work is expected to develop a prototype strategy with direct value in malaria vaccine, drug and diagnostic development, or with direct commercial value beyond malaria, including other pathogens of military relevance.

PHASE III DUAL-USE COMMERCIALIZATION: It is anticipated that the methodologies developed herein will be applicable for the functional analysis of a wide variety of pathogens and will include strategies for the rapid development of vaccines, drugs and diagnostics against well-established (i.e. TB, enteric diseases) and emerging (Ebola virus, hemorrhagic viruses and genetically-modified) pathogens. These technologies should ultimately transition to the characterization of certain cancers and autoimmune diseases and the development of novel therapeutics, especially in light of the potential early completion of the human genome. Phase III will demonstrate and validate the high throughput technology/methodology for malaria and lay the foundation for implementation/commercialization in malaria vaccine and drug development or in other fields.

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(2) Hoffman, S.L., Rogers, W.O., Carucci, D.J., Venter, J.C. (1998) From genomes to vaccines: Malaria as a Model System, Nature Medicine 4(12): 1351-1353. Outlines one strategy that may be employed to identify potential vaccine targets.
(3) Mariagrazia Pizza, Vincenzo Scarlato, Vega Masignani, Marzia Monica Giuliani, Beatrice Aricò, Maurizio Comanducci, Gary T. Jennings, Lucia Baldi, Erika Bartolini, Barbara Capecchi, Cesira L. Galeotti, Enrico Luzzi, Roberto Manetti, Elisa Marchetti, Marirosa Mora, Sandra Nuti, Giulio Ratti, Laura Santini, Silvana Savino, Maria Scarselli, Elisa Storni, Peijun Zuo, Michael Broeker, Erika Hundt, Bernard Knapp, Eric Blair, Tanya Mason, Hervé Tettelin, Derek W. Hood, Alex C. Jeffries, Nigel J. Saunders, Dan M. Granoff, J. Craig Venter, E. Richard Moxon, Guido Grandi, and Rino Rappuoli (2000) Identification of Vaccine Candidates Against Serogroup B Meningococcus by Whole-Genome Sequencing. Science; 287: 1816-1820

KEYWORDS: Functional Genomics, Malaria, Genome Sequencing, Genomics, Proteomics.

Army MRMC, Ft. Detrick, Topics

TOPIC NUMBER: OSD00-HP04 TITLE: Systems For Improved Red Blood Cell Storage

DOD CRITICAL TECHNOLOGY: BIOMEDICAL

ARMY TECHNOLOGY AREA: Life, Medical and Behavioral Sciences

ARMY MEDICAL PROPOSALS SHOULD BE MAILED TO
US Army Medical Research Acquisition Activity
MCMR-AAU (Herman Willis)
820 Chandler Street
Ft. Detrick, MD 21702-5014

OBJECTIVE: The objective is to improve the availability of red blood cells for emergency use by freeze-drying.

DESCRIPTION: Current blood bank technology allows the storage of human red blood cells in the liquid form (4^oC) for up to six weeks or frozen in glycerol for 10 years. Alternate storage methods of red blood cells would reduce wastage, cost and logistic footprint as well as allow increased availability in remote locations. Freeze-dried storage is the goal. Previous attempts to freeze-dry red blood cells have met with limited success. Ice formation is the major technical barrier preventing progress in freeze-drying. The objective is to develop transfusable *synthetic ice blockers* that bind nascent ice crystals and prevent them from growing. The process of systematic evolution of ligands by exponential enrichment (SELEX) is a potentially useful strategy. The objective is to develop oligonucleotides “aptamers” that bind to ice crystals preventing their growth. The understanding of ice crystal formation and growth and red blood cell tolerance to freeze-drying is a minimal requirement for developing a successful red blood cell product. Quality, safety, or ease of use must not be compromised.

PHASE I: Identify aptamers that bind ice crystals. Identify aptamers capable if limiting ice crystal growth. Define storage and reconstitution solutions containing aptamers.

PHASE II: Define large-scale freeze-drying process for red blood cells. Demonstrate reduced hemolysis and reduced methemoglobin formation preparations through storage studies. Perform or participate in clinical testing of the defined storage solution to include conventional *in vitro* testing of the stored red blood cells followed by *in vivo* testing with autologous human red blood cell recovery and survival studies. Demonstrate the storage solution provides an *in vivo* red blood cell recovery > 75% at 24 hours. Demonstrate that *in vitro* physiologic parameters and levels of hemolysis are acceptable to regulatory agencies.

PHASE III DUAL USE APPLICATIONS: Produce and support such a red blood cell storage product during its introduction into clinical use. A freeze-dried red blood cell preparation has significant commercial potential to provide red blood cells in austere environments where refrigeration and/or freezer facilities are not available.

KEYWORDS: blood, red blood cells, blood banking, ice crystal formation, aptamer, freeze-drying

REFERENCES: none

TOPIC NUMBER: OSD00-HP05 TITLE: <u>Blast Mitigation Jacket for Training</u>

DOD CRITICAL TECHNOLOGY: BIOMEDICAL

ARMY TECHNOLOGY AREA: A08

ARMY MEDICAL PROPOSALS SHOULD BE MAILED TO
US Army Medical Research Acquisition Activity
MCMR-AAU (Herman Willis)
820 Chandler Street
Ft. Detrick, MD 21702-5014

OBJECTIVE: Develop a lightweight jacket that modifies the impulsive noise loading to the thorax so that nonauditory effects can be mitigated.

DESCRIPTION: Soldier training using certain large caliber weapons, shoulder-fired anti-material weapons, and weapons fired from enclosures exceed tolerances for nonauditory injury, in particular injury to the lung from rapid chest wall motion. When these limits are exceeded, occupational safety considerations require that training be restricted or prohibited. Although this is a valid occupational concern, these limitations in training decrease the soldier's effectiveness in actual combat deployment and, therefore, could be detrimental overall.

Considerable research has been conducted to determine the biomechanical origin of this injury and some studies have shown that certain aspects of clothing, especially the effects of trapped air and areal mass density, can modify the loading seen by the body and therefore modify the biomechanical response. Other studies have shown that increasing the duration of loading, even if total impulse is not changed, can dramatically reduce traumatic body response.

PHASE I: Demonstrate the feasibility of using clothing materials, combined with control of air spaces, to alter the thoracic loading and to reduce the anticipated nonauditory hazard. Use the prototype tests to estimate the amount of protection in terms of jacket weight and bulk.

PHASE II: Refine and improve promising design concepts. Demonstrate the increased protection using prototype jackets.

PHASE III DUAL USE APPLICATION: The modification of impulsive loading to the body and subsequent reduction of trauma is a component of the design of ballistic garments worn by law enforcement and by bomb disposal personnel. Work with Army materiel developers to identify ways to incorporate these blast mitigation features into standard training clothing, if possible. Demonstrate the increased protection using actual jackets.

REFERENCES:

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KEYWORDS: blast injury, explosives, protective clothing, soldier training

TOPIC NUMBER: OSD00-HP06 TITLE: Analysis and Interpretation of Real-Time Multi-Parameter Biological Data

DOD CRITICAL TECHNOLOGY: Biomedical

ARMY MEDICAL PROPOSALS SHOULD BE MAILED TO

US Army Medical Research Acquisition Activity
MCMR-AAU (Herman Willis)
820 Chandler Street
Ft. Detrick, MD 21702-5014

TRADOC/BATTLE LAB INTEREST: Combat Service Support

OBJECTIVE: Identify and develop an expert system that can analyze real-time, continuous bioelectric signals for evidence of developing toxic conditions under variable environmental conditions.

DESCRIPTION: The U.S. Army Center for Environmental Health Research (USACEHR), in conducting research in the field of deployment toxicology, seeks an expert system for real-time assessment of biological endpoints monitored continuously to define the toxicity of environmental media. The expert system should have the following characteristics:

1. Provide a rapid response (e.g., within one hour) to toxicant-induced changes in the bioelectric signals.
2. Maximize sensitivity of response.
3. Minimize responses to variations in continuously-monitored non-toxic environmental variables.
4. Be adjustable for different endpoint response sensitivities.
5. Be applicable for continuous, on-line analyses.

PHASE I: Develop an expert system for analysis of bioelectric signals that can detect developing toxic responses while minimizing “false alarms” due to changes caused by non-toxicant related continuously-monitored environmental variables. Statistical method(s) will be original or will represent significant extensions, applications, or improvements over published methods. Experimentation must show that the expert system displays the above characteristics.

PHASE II: The prototype expert system developed under Phase I will be demonstrated through application to continuous bioelectric data from tests with various classes of chemicals including, but not limited to, heavy metals, organic solvents, and military unique substances. The expert system must differentiate toxic responses from those caused by variable environmental conditions.

PHASE III DUAL-USE APPLICATION: The expert system developed and validated during Phases I and II will be applied in a variety of configurations. By integrating and evaluating changes in bioelectric signals with environmental monitoring data, the expert system can be adapted and applied to field applications, such as a USACEHR-developed aquatic biomonitoring platform or monitors for developing hazards to troops. An expert system used in conjunction with multiple monitoring platforms and telemetry systems can be used to provide regional indications of health hazards in real-time. Applications include assessment of environmental hazards to troops pre-, during, and post-deployment. In addition, these methods may be used to monitor and assess the environmental impacts of military site activities and the compliance of such activities with regulatory requirements.

OPERATING AND SUPPORT COST REDUCTION (OSCR): An expert system that can identify developing toxic conditions in real time can provide invaluable information to commanders in the field and can help prevent catastrophic health consequences, performance decrements, and future health problems caused by environmental or occupational exposure to toxic industrial/agricultural chemicals and other environmental contaminants. Present statistical methods used in present remote biomonitoring technology cannot easily differentiate between responses due to toxic materials and those resulting from non-toxic changes in environmental variables. Current statistical approaches cannot detect developing toxic conditions as quickly as needed for decision-making under field conditions associated with military operations. The alternative to real-time toxicity monitoring is the collection and preservation of environmental samples, followed by transportation to a remote laboratory for testing, a procedure which is vastly more costly and time consuming and which is not useful for rapid decision making.

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